"I would have everie man write what he knowes and no more."—MONTAIGNE

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EDITORIAL

WHILST many anaesthetists may be tempted to feel that the relaxants were introduced to enable them to provide good surgical conditions with perhaps less effort and with more certainty, probably on reflection most would agree that, from the patient's viewpoint at any rate, their greatest blessing has been to make widely popular the use of the lightest planes of anaesthesia even for the most major operative procedures. This aspect of the use of these drugs has been welcomed by many, but others have been more cautious and have never lost sight of the principle to which attention was first drawn by Crile, that in light anaesthesia reflex responses to trauma may still be very evident. Thus Harris (1951) stated that "anaesthesia to the level of complete sensory loss should be maintained throughout in subjects curarized for surgical procedures". The stage of "complete sensory loss" implied not only unconsciousness but also freedom from reflex response to all but the most severe external stimuli and was equivalent to Guedel's plane 2. He points out that only in this stage is "the subject . . . freed from the deleterious consequences of the two uncontrollable variables, emotion and external stimulation, whose reflex effects upon the body cannot be anticipated either in respect to the intensity or the character of the response which is produced by them".

One may say without fear of serious contradiction that "emotional" stimulation, in the ordinary sense of the word, will cease when consciousness is lost, but those using the very lightest plane of narcosis always have in their mind the possibility that reflex reaction to stimuli arising in the abdomen, chest or larynx might produce dangerous circulatory upset.

The vago-vagal reflexes which are a result of surgical manipulation in the thorax or abdomen have in the past been rather neglected, but are now being investigated in more than one centre. They are likely to be in evidence at all stages of anaesthesia, although more commonly in light anaesthesia. Their incidence may be reduced either by local block of the afferent nerves in the coeliac plexus or, in all probability, by certain drugs affecting the autonomic nervous system.

The reflexes which may occur as a result of stimulation of the trachea or larynx, either by insertion or withdrawal of an endotracheal tube, have received a great deal of attention in recent years. Numerous investigators (Burstein *et al.*, 1950; King *et al.*, 1951; Converse *et al.*, 1952; King *et al.*, 1954) have established that changes in rate and occasionally in rhythm of the heart may occur with any form of anaesthesia during endotracheal intubation and extubation especially in light anaesthesia. The paper in this issue by Horton describes further investigations of these changes and confirms much of the previous work.

It would seem that these reflex responses to intubation are not of serious significance and are certainly not sufficiently disturbing to lead those anaesthetists, who have been persuaded of the advantages of light anaesthesia and of endotracheal intubation after induction with minimal doses of narcotics and relaxant agents, to change their techniques.

A CORRESPONDENT tells us that in our Editorial (May) we have attributed to him a statement regarding the dose of pethidine which in fact he did not make. We willingly accept his word for this and express our regret for the unfortunate misunderstanding, and our fullest apologies for the misrepresentation. Our May editorial was intended to be a plea for the use of reason rather than emotion in the appraisal of the value of anaesthetic techniques. We feel it is most unfortunate, if, in the course of that attempt, we have stirred up some resentment; such was certainly not the intention.

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ELECTROCARDIOGRAPHIC FINDINGS DURING LARYNGOSCOPY AND ENDOTRACHEAL INTUBATION

BY

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UNTOWARD effects upon respiration and circulation have long been known to occur following laryngoscopy and endotracheal intubation. Studies of the reflex circulatory effects of these stimuli, by means of continuous electrocardiograms or by tracings of arterial pressure and pulse waves, have sometimes revealed changes characteristic of cardiac inhibition or cardiac irritation. Reid and Brace (1940), and Burstein and co-workers (1950a, b), have suggested that these effects occur more commonly when the stimulus occurs in light anaesthesia. Significant support for this view from a pathologist is found in the reasonings of Simpson (1949) based on a review of deaths which occurred too swiftly for hypoxia or biochemical change to have been the cause, no anatomical cause being found at autopsy. Some of these deaths occurred during anaesthesia. He postulated a violent cardio-depressor reflex as the cause of death, and argued that, although anaesthesia might reduce the risk of such a reflex occurring, yet "adequate" anaesthesia was necessary to ensure sufficient protection against the reflex effects of endotracheal intubation, anal or cervical dilatation or peritoneal manipulation.

Deep anaesthesia may also give protection from reflex coughing or bronchospasm after intubation, events which may lead to cardiovascular changes due to hypoxia.

The facility gained by the use of muscle-relaxant drugs has led many anaesthetists nowadays to perform intubation in very light planes of anaesthesia without apparent ill-effect. Such techniques may permit adequate oxygenation before and after intubation to be maintained more readily (Rosner *et al.*, 1953; Colon-Yordan *et al.*, 1953). Perhaps, too, the muscle-relaxant drugs themselves may afford some protection against reflex disturbances (Wylie, 1950; Burstein *et al.*, 1950b). Thus there is a wide divergence of opinion and practice.

This paper deals with the electrocardiographic findings during laryngoscopy and oral endotracheal intubation in light and deep general anaesthesia given by semi-closed system without carbon dioxide absorption, in light anaesthesia with the aid of four muscle-relaxant drugs, and in cases where chloroform or trichlorethylene was used.

The investigation was undertaken to seek further evidence of the possible harmful reflex effects upon the heart of laryngoscopy and intubation, and the variations seen with differing anaesthetic techniques.

METHOD

Electrocardiograms were recorded upon a series of 219 patients undergoing surgical anaesthesia.

The first tracing was made before or immediately after the induction of anaesthesia, subsequent traces were taken at intervals, and a continuous recording made during and after endotracheal intubation. In approximately half the cases the trace was taken during laryngoscopy as well.

Various agents were used for induction and maintenance of anaesthesia to achieve the conditions needed for intubation (table I); the agents used were those adopted by the personal choice of the anaesthetist concerned.

Age of patients ranged from 5 to 83 years.

Cases with auricular fibrillation were excluded, otherwise no notice was taken of any cardiac lesion on clinical or electrocardiographic grounds found at preoperative examination.

Premedication was light. Morphine 1/8–1/6 grain (8–10 mg) with atropine 1/120 grain (0.5 mg), or papaveretum 1/3 grain (20 mg) with scopolamine 1/150 grain (0.45 mg). Children received a smaller dose of morphine and atropine, or else quinalbarbitone (Seconal) with atropine.

The electrocardiograph used is a direct writing unit working on the thermionic principle, and embodying precautions against the risk of fire. It was constructed by L. Molyneux, Research Assistant in the Department of Anaesthetics. A marking device permits the precise timing of events studied to be recorded directly on the trace.

Care is necessary to obtain a "clean" trace, free from artefact due to muscle potentials, movement, and so forth during anaesthesia and operation. Unnecessary electrical apparatus should be disconnected and the patient be handled as little as possible. The greatest benefit is gained by the use of needle electrodes placed subcutaneously in the chest wall. Ordin-

TABLE I

Agents used before intubation

1. *Inhalation anaesthesia* (102 cases)

Inhalation agents	Thiopentone induction	Inhalation alone	Total
Nitrous oxide, trichlorethylene, ether	28	11	39
Nitrous oxide, ether	12	14	26
Nitrous oxide, chloroform, ether	18	5	23
Nitrous oxide, chloroform	5	2	7
Nitrous oxide, methyl-n-propyl ether	7	0	7
	70	32	102

2. *Relaxant drugs* (117 cases)

Relaxant drug	Thiopentone	Thiopentone + light inhalation anaesthesia	Total
d-Tubocurarine chloride	33	5	38
Decamethonium iodide	19	3	22
Suxamethonium	40	0	40
Gallamine triethiodide	15	2	17
	107	10	117

ary sterile hypodermic needles (gauge 17 or 20) are used, one placed one inch below and lateral to the apex beat, the other on a line between the apex beat and the right axilla two or three inches away from the heart, usually in the second or third right intercostal space. Leads are connected to the needles by crocodile clips. A trace essentially similar to standard lead II is obtained with, however, a large amount of the musculature put "out of circuit". Muscle potential and the effect of movement are largely abolished.

STUDIES MADE

All traces were examined for abnormalities of rate, rhythm and complex form, according to the agents used for anaesthesia, and to any specific stimulus noted.

The following measurements were made:

I. *The heart rate averaged over* 10 *beats was calculated in each case for the following times*:
1. Immediately before intubation.
2. Immediately after intubation.
3. At 20 beats after intubation.
4. At 30 or 60 seconds after intubation.

The results were expressed as a percentage of (1)—the rate before intubation.

II. *The heart rate was similarly measured, where relevant, before and after laryngoscopy and attempted intubation.*

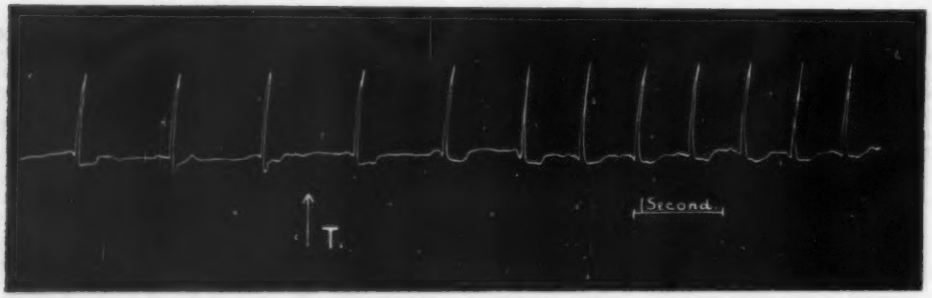
To compare the effect of various anaesthetic routines upon the events occurring at laryngoscopy and intubation, the cases were divided into the following groups:

1. Light anaesthesia with thiopentone and a relaxant drug ("relaxant group").
2. Light anaesthesia chiefly with inhalation agents.
3. Cases receiving chloroform or trichlorethylene ("halogen group").
4. Cases deeply anaesthetized with inhalation agents (Guedel plane 3 or 4), in which no reflex respiratory response was seen at intubation.

RESULTS

A. *Endotracheal Intubation.*

Tachycardia. The most common sequel to intubation was the appearance of tachy-

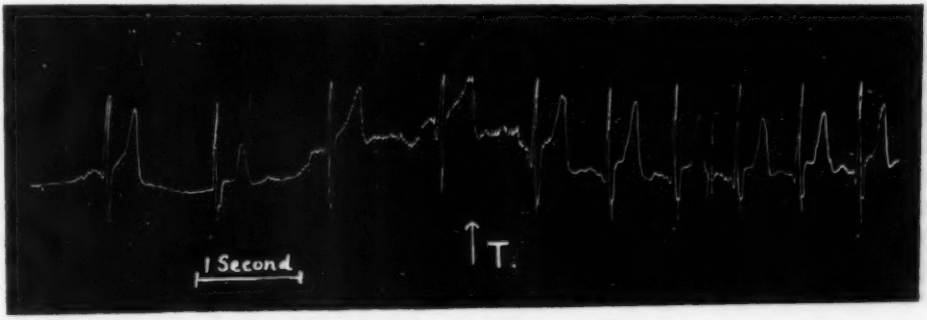


TRACE 1

Nitrous oxide/ether. Plane 2. Sinus tachycardia after intubation at T.
Rate: 57/min before intubation.
117/min after intubation.

cardia; this occurred in 181 cases. In three there was no change in heart rate and in 35 there was slowing.

When tachycardia occurred it began promptly after intubation (traces 1 and 2), although a further increase in rate frequently occurred slightly later, often following coughing or breath-holding (trace 3), perhaps as a result of additional stimulus from the presence of, or movement of, the endotracheal tube within the trachea; this event is frequently noted clinically to be somewhat delayed in onset. Table II illustrates the sequence of events in the various groups of cases; most groups show the tendency to a further delayed increase in rate. Tachycardia is most marked in the cases anaesthetized with inhalation agents, especially when the halogen-containing drugs trichlorethy-



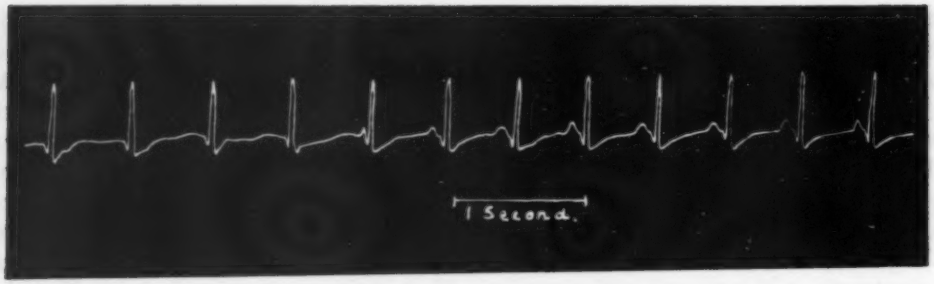
TRACE 2

Nitrous oxide/ether. Plane 2. Sinus tachycardia after intubation at T.
Rate: 60/min before intubation.
100/min after intubation.

TABLE II

Comparison of heart rates after intubation in various groups of cases
Average heart rate over ten beats before intubation = 100 per cent

	Mean percentage heart rate after intubation		
	1–10 beats after	20 beats after	30 or 60 seconds after
All cases	107	117	117
Relaxant drugs			
d-Tubocurarine chloride ...	108	120	121
Decamethonium iodide ...	100	105	103
Suxamethonium	102	107	108
Gallamine triethiodide ...	101	105	114
Halogen drugs			
Trichlorethylene	110	125	121
Chloroform	116	136	133
Deep anaesthesia	110	118	120
Light inhalation anaesthesia ...	108	117	120
Cases showing slowing	93	107	109



TRACE 3

Nitrous oxide/ether. Plane 2. Breath holding after intubation. Return of displaced pacemaker to SA node, with slight tachycardia.

lene and particularly chloroform had been used. When relaxant drugs were used to aid intubation in light anaesthesia, the heart rate was more constant, although when d-tubocurarine chloride was used the rate was faster than in the series as a whole.

Bradycardia. Slowing of the heart rate after intubation occurred in 35 cases. This was only minimal in most cases; in only one patient did the rate fall to 72 per cent of that before intubation; in two others there was a slight sinus bradycardia. There was no other evidence of cardiac inhibition following intubation.

Comparing the groups of cases, it is noticeable that bradycardia occurred most frequently (table III) in the relaxant group. No slowing of the heart rate occurred in the cases deeply anaesthetized nor in the cases lightly anaesthetized with inhalation agents other than when the halogen-containing drugs were used. The remainder of the cases of bradycardia occurred when chloroform or trichlorethylene had been used. There is a significant difference ($P = 0.02$ approx.) when the occurrence of bradycardia with light anaesthesia (relaxant group) and the absence of it with deep anaesthesia are compared (table IV). When the group of cases intubated with the aid of a muscle relaxant drug producing its effect by myoneural junction block (d-tubocurarine chloride and gallamine) is compared

TABLE III

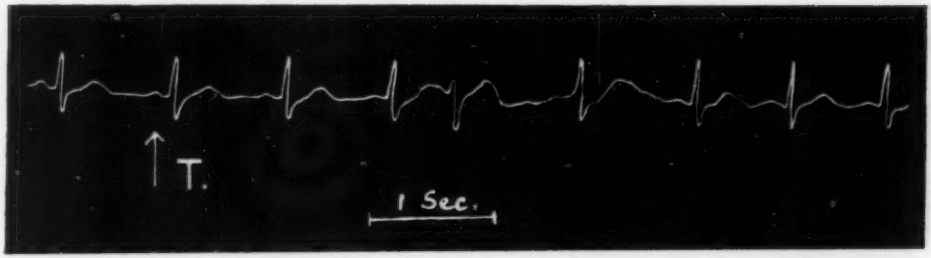
Distribution of cases showing bradycardia after intubation

	Number of cases	Number with bradycardia
Relaxant drugs		
d-Tubocurarine chloride	38	3
Gallamine triethiodide	17	2
Suxamethonium ...	40	11
Decamethonium iodide	22	7
Chloroform	30	3
Trichlorethylene	47	9
Deep anaesthesia	28	0
Light inhalation anaesthesia	34	0
		35

TABLE IV

Distribution of cases showing extrasystoles and bradycardia after intubation

	Total cases	Slowing	Extra-systoles	
All cases	219	35	18	171
Relaxant group	117	23	5	91
Halogen group	77	12	8	60
Deep anaesthesia	28	0	5	23



TRACE 4
Nitrous oxide/ether. Plane 3. Intubation at T. Extrasystole and slight tachycardia.

with the group where a depolarizing agent (decamethonium, suxamethonium) is used there is a definite tendency for slowing of the heart to occur in the latter group ($P<0.02$). Five cases out of 55 showed bradycardia with the former and eighteen out of 62 with the latter group of drugs. This is possibly due to the ability of the myoneural blocking agents to paralyse parasympathetic ganglia and so perhaps to lessen any reflex occurrence of a vagotonic nature (Mautner and Luisada, 1941; Doughty and Wylie, 1951).

Extrasystoles. These were seen at or after intubation in 18 cases. The ectopic beats were ventricular in 14, AV nodal in one and auricular in three cases. No case of ventricular tachycardia was seen.

There was a slight tendency ($P<0.05$) for extrasystoles to occur in the deeply anaesthetized cases rather than in the light (relaxant) group (table IV). In the series as a whole, extrasystoles were more frequent in older patients.

	Over 50	Under 50	
Extrasystoles	14	4	$\chi^2=8.24$
No extrasystoles	80	121	$P<0.01$

In five cases extrasystoles occurred together with bradycardia after intubation. This did not appear to be due to ventricular escape.

B. *Laryngoscopy.*

Table V shows the changes observed during laryngoscopy before oral intubation. Tachycardia was again common, though bradycardia was seen in a larger proportion of cases than following intubation. Electrocardiograms were recorded during laryngoscopy in only 106 of the 219 cases studied, yet bradycardia was seen in 43 of these. Slowing of the heart was a more frequent event in the relaxant and halogen groups, as was the case after intubation, although it was nearly twice as common after laryngoscopy. However, no significant potentiation of a vagal effect was seen when the traces were followed through the two stimuli. Of the 43 cases showing bradycardia after laryngoscopy, only eight showed bradycardia at subse-

TABLE V
Comparison of changes following laryngoscopy

	Total cases	Slowing	Extra-systoles	Neither
All cases	106	43	3	60
Relaxant group	60	26	1	33
Halogen group	40	8	3	29
Deep anaesthesia	14	6	0	8

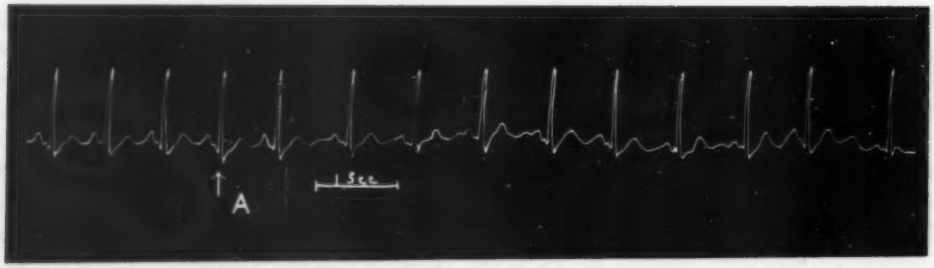
quent intubation. In the 63 cases which did not show this, the heart rate slowed after intubation in seven.

	Laryngoscopy	Bradycardia at subsequent intubation
Bradycardia	43	8
No bradycardia	63	7

Extrasystoles occurred in only three cases after laryngoscopy.

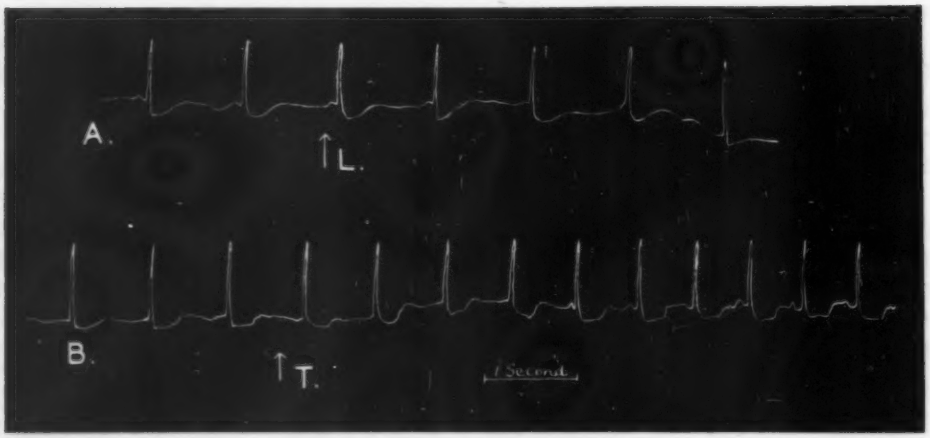
C. *Attempted Intubation.*

Previous unsuccessful attempts at intubation had been made and were recorded in 29 cases. In four of these bradycardia followed the attempt (trace 5). On 10 occasions laryngeal or bronchospasm with hypoxia ensued and this was sometimes seen to cause characteristic changes in the E.C.G. record: ST segment depression, inversion of T wave, or depression of P wave.



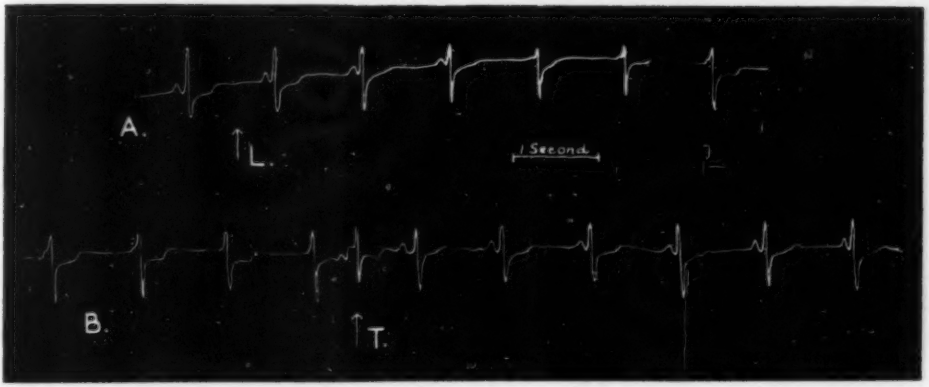
TRACE 5

Thiopentone and decamethonium iodide. Sinus rhythm.
Attempted intubation at A followed by bradycardia and arrhythmia.



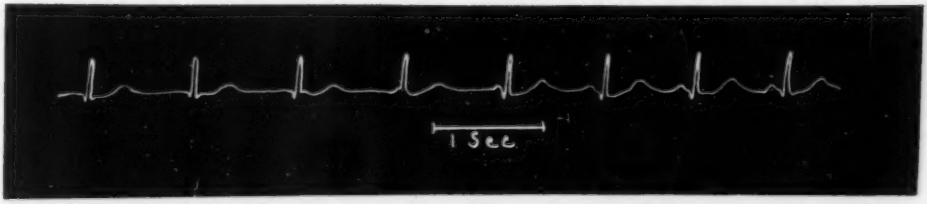
TRACE 6

Nitrous oxide/ether. Plane 2. Sinus rhythm.
Laryngoscopy at L followed by nodal rhythm. Pacemaker returns to SA node after intubation at T.



TRACE 7

Sinus rhythm. Displacement of pacemaker after laryngoscopy (L).
Intubation at T. Auricular extrasystole and resumption of sinus rhythm.



TRACE 8

Nitrous oxide/ether. Lightening of anaesthesia, breath holding, return of pacemaker to SA node.

TRACE 9

Nitrous oxide/ether. A (coupled ventricular extrasystoles) before and B (sinus rhythm) immediately after a coughing bout.

Other Effects Observed.

AV nodal rhythm was seen most commonly in association with deeper planes of anaesthesia, but in some cases followed the stimulus of laryngoscopy or attempted intubation (traces 6 and 7). The pacemaker returned to the SA node after intubation, but often not promptly, suggesting that the resumption of normal rhythm was due to lightening of the plane of anaesthesia or to a sympathetic stimulation occurring at that time (trace 8).

Ventricular extrasystoles were seen occasionally with deep anaesthesia. In three cases the stimulus of intubation caused a reversion to sinus rhythm (trace 12).

Coughing and breath holding were never followed by bradycardia. Extrasystoles already present were abolished by coughing on two occasions (trace 9) and were twice initiated by a similar stimulus (trace 10).

DISCUSSION

Potentially dangerous cardiac effects following a stimulus such as laryngoscopy or intubation may be due to:

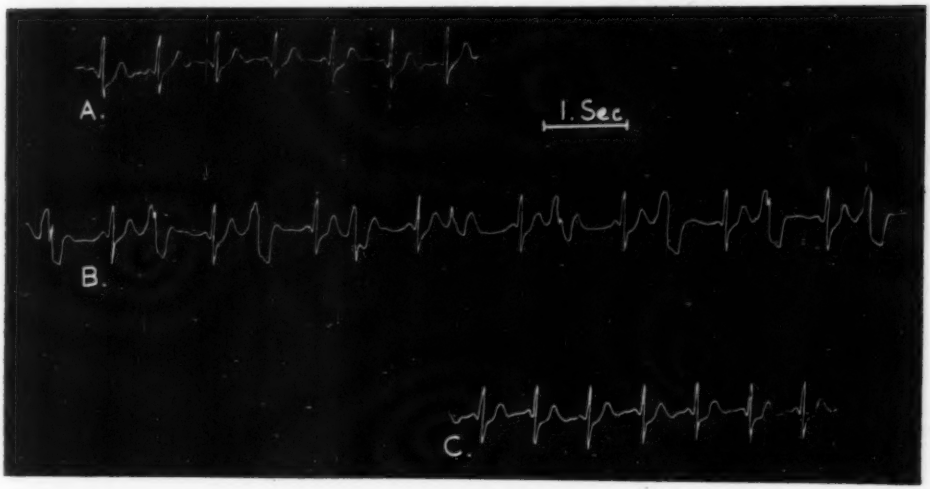
1. *Cardiac irritation.* Characterized by the production of ventricular ectopic beats or ventricular tachycardia.

2. *Cardiac inhibition.* With the production of a sinus bradycardia (sinus rate below 60/min) or a decrease of auricular rate of 25 per cent or more, whether accompanied or not by ventricular escape or auriculo-ventricular block.

In this series none of the changes seen were severe, and evidence of cardiac inhibition was minimal. Bradycardia was more common with the use of thiopentone and the relaxant drugs, especially the depolarizing agents, though it was of a degree compatible with the definition of cardiac inhibition above in only three cases. Colon-Yordan *et al.* (1953), Rosner *et al.* (1953), and Converse *et al.* (1952), using thiopentone and relaxants, found no evidence of bradycardia in their cases. Seventeen of the patients now reported had ventricular rates below 60 before intubation, in all but one this was associated with deeper planes of ether or chloroform anaesthesia (trace 11) and was accompanied by changes in the E.C.G. (ST wave depression, P and T wave depression or AV nodal rhythm. There was an increase in heart rate in all but one of these cases after intubation, probably due to lightening of the plane of anaesthesia, or to release of vagal tone due to dilution of the irritant anaesthetic vapour after removal of the face mask (Johnstone, 1952).

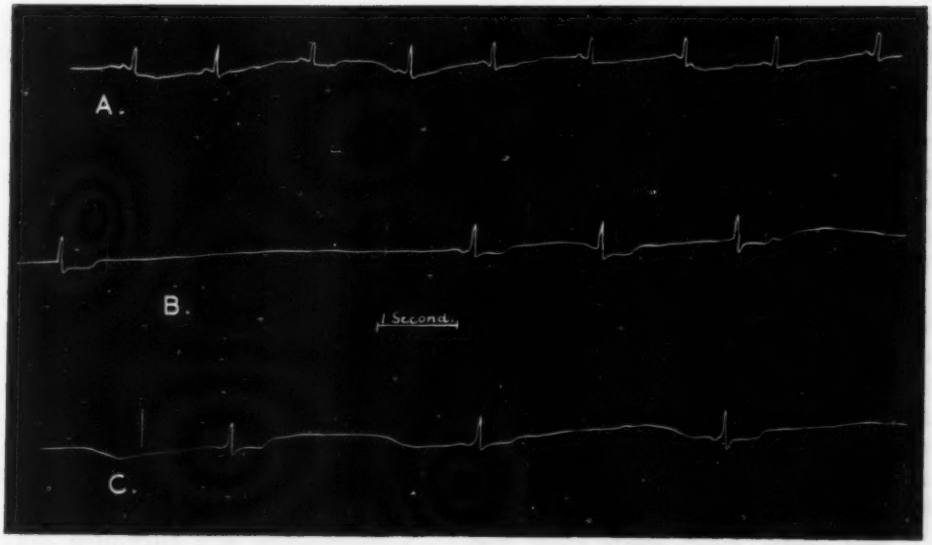
While bradycardia did not occur when intubation was performed in deep anaesthesia, possibly supporting the view of the greater safety thus obtained, yet the other effects of deep anaesthesia seen on the E.C.G. traces were quite common and could indicate vagal overtone or myocardial hypoxia. Probably the greater safety of deep anaesthesia lies in the comparison with light anaesthesia when coughing or previous attempts at intubation have led to the occurrence of hypoxia with resulting myocardial depression (Gillespie, 1948), rather than with the excellent conditions possible with the aid of muscle relaxants.

Laryngoscopy and previous attempts at intubation were followed by bradycardia more commonly than actual intubation. These stimuli did not potentiate a vagal



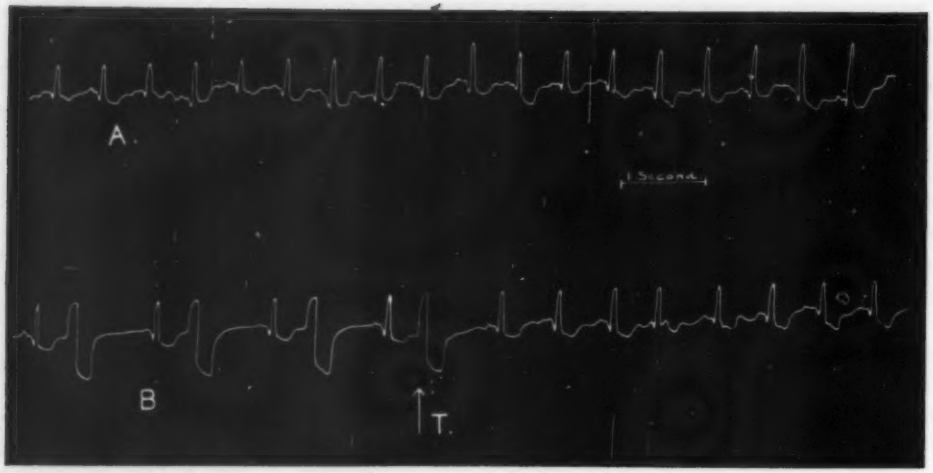
TRACE 10

Nitrous oxide/ether. Plane 2. A, C. Sinus rhythm.
B. Multifocus ventricular extrasystoles during coughing bout.



TRACE 11

Nitrous oxide/ether. A. Plane 2. B, C, Plane 3.
Marked bradycardia and irregularity with ST segment depression and inversion of T wave.



TRACE 12

A. Nitrous oxide/ether. Plane 1. Sinus rhythm, ST depression.
B. Plane 2. Coupled ventricular extrasystoles. Resumption of sinus rhythm after intubation at T.

effect later. Attempted intubation was sometimes accompanied by E.C.G. changes typical of the hypoxia which was seen clinically.

Evidence of cardiac irritation was seen in the appearance of ventricular ectopic beats. No case of ventricular tachycardia occurred. Ectopic beats were more common in cases deeply anaesthetized, or with the use of halogen drugs.

A significant difference in the age incidence was seen, extrasystoles being more common in the older patients. Burstein *et al.* (1950a) found sinus tachycardia (heart rate over 100 beats per minute) to be the usual sequel to intubation. This was seen in only seventeen of the cases in this series despite an increase in heart rate in 181. In sixty cases sinus tachycardia was present before intubation, the rate slowed in thirteen of these after intubation.

SUMMARY

Continuous electrocardiograms were recorded during anaesthesia and endotracheal intubation in 219 cases.

Practical details are given. The use of needle electrodes inserted in the anterior chest wall helped to give a " clean " trace free from artefact.

No marked evidence of either cardiac irritation or inhibition was seen.

Bradycardia was more common when laryngoscopy and intubation were performed in light anaesthesia aided by muscle-relaxant drugs. No case of bradycardia occurred when intubation was performed in deep anaesthesia, although this was offset by other changes, possibly due to the anaesthetic agents themselves.

Laryngoscopy and attempted intubation did not potentiate any reflex vagal effects at intubation.

ACKNOWLEDGMENTS

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INTRAMUSCULAR SUXAMETHONIUM

BY

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THE South American Indian hunting his prey and unable to administer an intravenous dose of his lethal "Wourali", was satisfied if his quarry suffered a more lingering fate from a poison dart quivering in its muscles. By the same token, the anaesthetist, unless he has the sleight of hand which comes to few, will find difficulty in canalising the veins of the small, wriggling infant with whom he is occasionally presented. Often he must be content to produce a more conventional paralysis with ether. In view of the South American success with intramuscularly injected curare, it was decided to investigate the effect of the administration by the same route of one of the most rapidly acting relaxants so far discovered —suxamethonium chloride (succinyl dicholine chloride).

Relaxants have been administered by routes other than intravenous, but so far as can be determined, full relaxation has not been obtained by such methods, except for the paralysis induced in the she-ass by Waterton in 1812. In 1947 Smith of Utah described the use of curare in children's surgery, and 21 of his cases were "anaesthetized" with intramuscular curare alone, but without, so far as can be gathered, respiratory paralysis. In investigating methods of administering mephenesin Wyngaarden, Tieche and Seevers (1949) obtained significant plasma levels after intramuscular injection, and used the method to obtain minor degrees of sedation and relaxation in animals and one human subject. By injecting d-tubocurarine into the muscles of the abdominal wall Borghetti (1951) obtained excellent operative conditions, and claimed that the relaxation was confined to the muscles injected. Thuillier (1952) gave large doses of d-tubocurarine rectally and obtained mild, but prolonged relaxation in neurological and psychiatric disorders. Voorhoeve (1952) described a method of inducing anaesthesia in children, in which a combination of rectal thiopentone (45 mg/kg body weight), intramuscular gallamine triethiodide (4 mg/kg body weight) and cyclopropane were used, which provided satisfactory conditions for intubation. Presumably, there was no attendant apnoea, as anaesthesia was then maintained with nitrous oxide and trichlorethylene, using an Ayre's T-piece. Intrahepatic injections of d-tubocurarine (Jelly, 1948) and the use of the peritoneal route (Piccoli and Ruggiero, 1952), have also been reported. The most recent and novel work is that of Goetz (1955) who, wishing to capture live giraffes for haemodynamic researches, reverted to poison arrows fired by members of the University of Capetown Archery Club to assist in

their capture. Most of these authors carried their techniques short of complete apnoea.

The purpose of this investigation was to determine a satisfactory method of intubating small children, which would provide conditions comparable with those obtained in adults by the more conventional intravenous injection of thiopentone and suxamethonium chloride. At the same time, possibilities of maintaining muscular relaxation without recourse to intravenous injections were examined.

INVESTIGATION

We wished to know whether suxamethonium (Scoline) injected intramuscularly either alone or mixed with hyaluronidase (cf. hyperdermoclysis in infants, etc.: Schwartzman, 1949; Kimbell, 1954) would provide adequate conditions for intubation and subsequent muscular relaxation. It was also necessary to discover the rate at which the drug took effect, its duration, the dosage required, and any undesirable side effects of the technique.

Complete or near apnoea was regarded as the criterion for satisfactory intubation since this state is associated with little or no reaction when an endotracheal tube is passed. Conditions less satisfactory than this may lead to trauma, and undesirable vagal reflex responses. Patients of all age groups were used in this investigation, being accepted without selection, and anaesthesia was induced in a standard fashion.

Premedication varied somewhat from case to case, but, in general, adults received subcutaneous injections of papaveratum 1/3 grain (20 mg) and scopolamine 1/150 grain (0.4 mg) one hour before anaesthesia. Small children received pentobarbitone (Nembutal) orally in a dose of 3/4 grain/st body weight (6 mg/kg) together with atropine sulphate, while older children were premedicated in a similar manner to adults.

Anaesthesia was induced with intravenous thiopentone in a standard dose of 35 mg/st (2.5 mg/kg), and maintained with nitrous oxide and oxygen at flowrates of 6 and 2 litres per minute respectively. When breathing returned to normal, suxamethonium was injected intramuscularly.

As depression supervened, respiration was assisted until apnoea occurred or depression reached a maximum. This was determined by clinical observation as efforts at spirometry were unsatisfactory under the conditions pertaining during routine surgical lists. During this period, the presence or absence of muscular twitching was noted. The patients were then intubated and controlled respiration maintained at a rate and volume considered adequate for stabilization of oxygen and carbon dioxide tensions at normal levels.

The first sign of returning respiration and the time at which respiration in terms of depth, rate, and rhythm appeared normal were observed. The latter observation could not be defined with an exact end point, but was taken as the time agreed by two observers.

Small children asleep under pentobarbitone, received suxamethonium without further anaesthesia, but a few, unsedated, were induced with ethyl chloride and ether on an open mask until consciousness was

lost when the suxamethonium was injected.

RESULTS

Group A (30 cases)

This was a trial group of patients anaesthetized with varying doses of intravenous thiopentone, and intramuscular suxamethonium with hyaluronidase. The results were sufficiently encouraging to warrant a further trial and gave an idea of the dosage needed for intubation. Such a dose should also give adequate muscular relaxation for surgery.

It was considered that intubating conditions were perfect only when apnoea was present, and there was no response (or very little) to the passage of an endotracheal tube. Under such conditions, there was no glottic spasm if the endotracheal tube was removed immediately. Conditions were considered inadequate if there was glottic spasm on laryngoscopy, marked reaction to intubation, or where there was failure to pass the tube. From this series, it became apparent that thiopentone in a dosage of 35 mg/st (2.5 mg/kg) intravenously, together with suxamethonium 1 mg/lb (2 mg/kg) mixed with hyaluronidase in the proportion of 100 mg suxamethonium to 1 ampoule hyaluronidase and given intramuscularly were adequate.* Doses of suxamethonium considerably less than this were sufficient to maintain quiet anaesthesia with quite small doses of thiopentone.

Group B (51 cases)

Fifty-one unselected patients were anaesthetized in the manner described. They then received suxamethonium in a dose of 1 mg/lb (2 mg/kg) mixed with hyaluronidase. The results are shown in table I.

TABLE I

No. of cases	Apnoea and easy intubation	Near apnoea and satisfactory intubation	Unsatisfactory intubating conditions
51	41	7	3
41 apnoeic cases	**Onset of apnoea.**	**Initial return of respiration**	**Return to normal respiratory excursion**
Response time:			
Mean	2.3 min	7.3 min	14.7 min
Range	0.75–4.0	3.5–18	8–24

The time relationships for the onset of maximum respiratory depression and recovery of respiratory function of the near apnoeic patients were similar to those exhibited by the apnoeic patients (fig. 1).

Group C (26 cases)

This group consisted of 26 unselected cases anaesthetized in the standard manner. They received suxamethonium in a dosage of 1 mg/lb (2 mg/kg) without hyaluronidase. The findings are shown in table II.

Of the 26 cases, adequate intubating conditions were present in only 10. The method was therefore considered unsatis-

* Ampoules of hyaluronidase provided by different manufacturers have different units of dosage, but all preparations contain similar quantities of active substance.

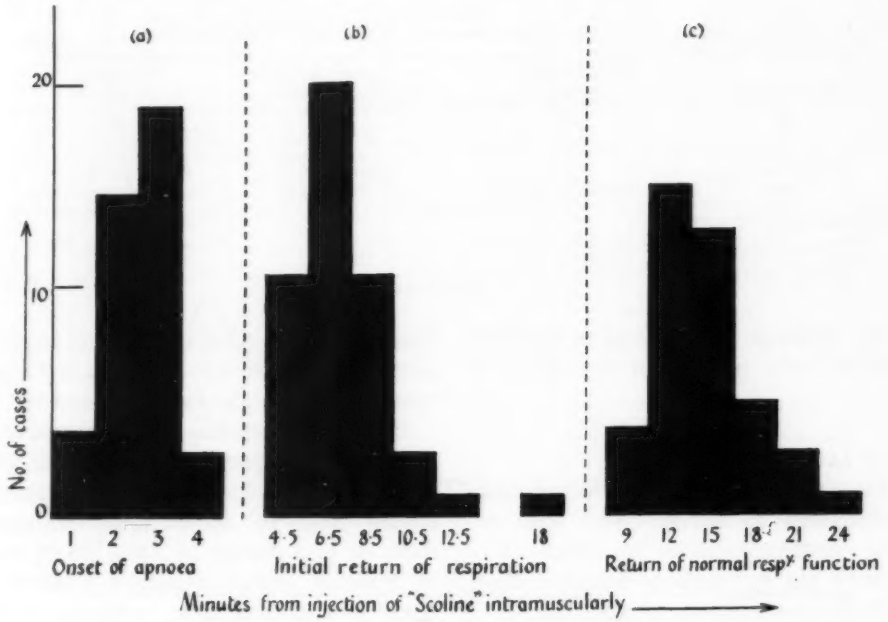

FIG. 1

Group B. Suxamethonium 1 mg/lb with hyaluronidase. Forty-one cases with apnoea.

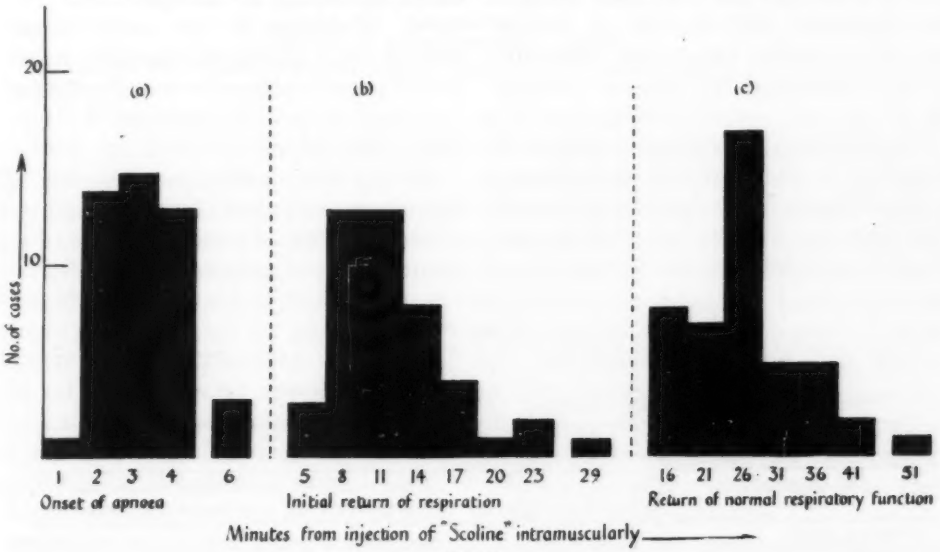

FIG. 2

Group D. Suxamethonium 2 mg/lb. Forty-five cases with apnoea.

TABLE II

No. of cases	Apnoea and easy intubation	Near apnoea and satisfactory intubation	Unsatisfactory intubating conditions
26	6	4	16
10 satisfactory cases	**Onset of apnoea**	**Initial return of respiration**	**Return to normal respiratory excursion**
Response time:			
Range	3.7 min	8.5 min	18.3 min
Mean	2.5–6.0	6–15	12–20

factory, although some degree of muscular relaxation was present in the other 16 cases.

Group D (50 cases)

This consisted of 50 unselected cases anaesthetized as before, who then received suxamethonium in doses of 2 mg/lb (4 mg/kg) without hyaluronidase. The findings are shown in table III.

The few cases of near apnoea showed time relationships for maximum respiratory depression and recovery of respiration of a similar range and character to those exhibited by apnoeic patients (fig. 2).

The response of patients in groups B, C and D is illustrated in an arbitrary fashion in figure 3, the three waves of each curve representing the onset of apnoea, the return and full recovery of respiratory function. For comparison, the range of response to intravenously injected suxamethonium has also been represented.

From these results, it became apparent that a high proportion of successful intubations can be expected where suxamethonium (1mg/lb) mixed with hyaluronidase, or in a dosage of 2 mg/lb by itself is injected intramuscularly. However, there is a greater time variation in response, and a slower overall time with the latter method. At dosages lower than these, intubation is less easily accomplished but a degree of muscular relaxation of considerable value may be attained.

Other Observations.

Of all the cases recorded, only 27 showed muscular fibrillary twitching and in the majority of these, this was a local occurrence and appeared soon after in-

TABLE III

No. of cases	Apnoea and easy intubation	Near apnoea and satisfactory intubation	Unsatisfactory intubating conditions
50	45	2	3
45 apnoeic cases	**Onset of apnoea**	**Initial return of respiration**	**Return to normal respiratory excursion**
Response time:			
Range	2.9 min	11.8 min	26.1 min
Mean	1–6	4–29	14–50

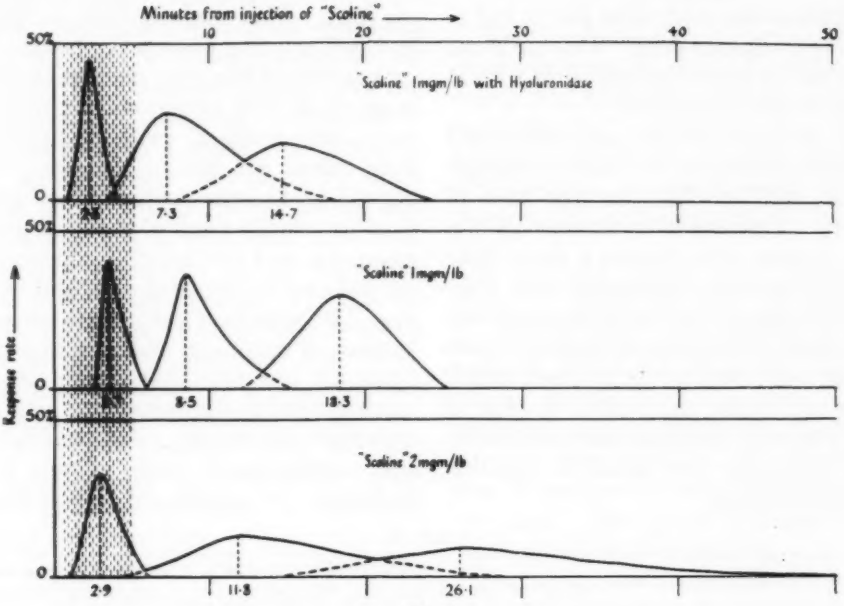

FIG. 3

In each curve the three waves represent:
1. Onset of apnoea.
2. Initial return of respiration.
3. Recovery of normal respiratory function.

The shaded area represents the usual range of response to intravenously injected suxamethonium.

jection. A few cases showed generalized twitching one to three minutes later, but there was no obvious correlation of twitching with a particular technique.

In a small number of cases, repeated blood pressure recordings showed no appreciable alteration in either systolic or diastolic pressures after the intramuscular injection of suxamethonium. Any rises in blood pressure that did occur were associated with laryngoscopy and intubation, as may be found with the intravenous administration of suxamethonium.

A constant and peculiar finding of this investigation was a prolonged postanaesthetic sleep period which persisted for up to half an hour, even in patients who had received as little as 280 mg of thiopentone, and in whom respiration and muscle tone appeared normal. This may bear some relationship to the frequent observation of amnesia in patients who have suffered from so-called "Scoline apnoea", and who have been artificially ventilated with air or oxygen. One may wonder whether the breakdown product, succinyl monocholine chloride, has any central narcotic effect, normally unrecognized because of the usual evanescent activity of the drug.

No pain or other reaction has been seen at the site of the injection.

In this series, one child regurgitated and inhaled stomach contents, but it was felt that this accident was attributable not to

the intramuscular technique *per se*, but to the use of a relaxant drug. This child has since been re-anaesthetized in a similar manner without incident.

Age, physical fitness, and, associated with these factors, the circulation through muscles, had an effect on the rate of response. This was best demonstrated in young children who showed a more rapid onset of respiratory depression than older subjects, although the rate of recovery was not so markedly increased. Table IV gives the time relationships for children below the age of 5 years, the greater number of whom received intramuscular suxamethonium following pre-operative sedation with pentobarbital.

TABLE IV

	Onset of apnoea	Initial return of respiration	Recovery of normal respiratory excursion
Group B (9 cases) (1 mg/lb suxamethonium with hyaluronidase)	1.4 min	6.3 min	11.4 min
Group D (4 cases) (2 mg/lb suxamethonium)	1.5 min	8.75 min	19.5 min

It is of interest that of the 11 subjects from all groups with apnoea supervening within 1.5 minutes of injection, nine were children, eight of whom were under five years of age.

Failure to respond adequately to intramuscular suxamethonium was not confined to any particular age group, and in view of the previous observation it is interesting to note that two children were insufficiently relaxed to allow intubation.

DISCUSSION

The rate of onset of muscular relaxation and respiratory depression is due to the rapidity of absorption of suxamethonium into the blood stream, and the production of significant plasma levels of the drug. That hyaluronidase is effective in hastening this process is obvious from comparison of the times of onset of apnoea in group B (with hyaluronidase, mean 2.3 min), and group C (without hyaluronidase, mean 3.7 min). Doubtless, lower plasma levels were reached in all groups than are usually attained with intravenous injections, and this belief is supported by the reduced incidence of muscular twitching. The activity of the drug is prolonged because of continued and slow absorption from the intramuscular depot, which is not subjected to the destructive activity of pseudocholinesterase. Presumably also, this comparatively large volume is not destroyed in significant quantities by cholinesterase present at the neuromuscular end plate. Because of the large quantities of suxamethonium used, it is conceivable that succinyl monocholine chloride is partly responsible for the prolonged depression of muscular activity. But, since succinyl monocholine chloride has only one fiftieth the activity of the dicholine and even in adults the average intramuscular dose of the dicholine was only of the order of 300 mg, this explanation seems unlikely.

THE APPLICATION OF THE METHOD

The promising field of usefulness, and that for which the investigation was undertaken, is in the realm of paediatric anaesthesia. Excellent conditions for

intubating babies and maintaining controlled respiration with good operating conditions over a prolonged period are provided. Because difficulties may be encountered in attempting to inflate newborn babies with a mask, it is probable that the technique described by Rees (1950) of intubating infants awake and unparalysed, is to be preferred. However, subsequent relaxation should be maintained with suxamethonium in preference to d-tubocurarine (Stead, 1955). Between the ages of one month and five years, anaesthesia induced with a basal sedative (of which rectal thiopentone is the most satisfactory, McDonald, 1953), followed by intramuscular suxamethonium, gives ideal conditions whenever endotracheal intubation is desirable.

During the investigation, it became apparent that the method could be applied to adults with advantage, more for the maintenance of quiet anaesthesia than for facilitating intubation. Thus, in the delivery room or operating theatre where a vein may be difficult to find in a fat subject, recourse has been had to the method with satisfaction. In such patients, the anaesthetist, despairing of finding a vein, may resort to inhalation techniques for induction in the knowledge that intramuscular suxamethonium will provide relaxation for intubation if necessary. The advisability of adding hyaluronidase may be determined by the duration of apnoea or total effects which are acceptable. The addition of hyaluronidase produces a more rapid onset, and a considerably shorter time range, but this is attained at a slightly increased cost and with the added complication of one more drug to be included in the anaesthetist's armamentarium.

SUMMARY

The intramuscular injection of suxamethonium is a satisfactory means of providing muscular relaxation for intubation and surgery. Although the original intention was to investigate a method of administering suxamethonium to small children, it has also proved satisfactory in adults.

Predictable results were obtained by injecting suxamethonium in doses of 1 mg/lb (2 mg/kg) body weight with hyaluronidase, or 2 mg/lb (4 mg/kg) body weight without hyaluronidase. In both instances apnoea supervenes two to three minutes after injection, but the recovery time is protracted when hyaluronidase is not used. The initial response is more rapid in infants than adults.

No undesirable side-effects, local or general, were seen.

The doses advised are intended to provide conditions for intubation similar to those following intravenous suxamethonium, but smaller doses will provide a degree of muscular relaxation which may be useful in other circumstances.

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CHLORPROMAZINE ("LARGACTIL") AS AN ANALGESIC IN LABOUR

A Report of 127 controlled cases

BY

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OF the many pharmacological properties of chlorpromazine ("Largactil", May & Baker, Ltd.), its sedative action on the central nervous system, and its potentiating effects on analgesics would seem to indicate that it might be of value in relieving pain in labour.

The effect of chlorpromazine in potentiating analgesic drugs and its "pharmacological leucotomy" action have recently been put to use in the treatment of other painful conditions. Administered to patients with malignant disease chlorpromazine relieved pain, muscle spasm, apprehension, and promoted a sense of well-being and a decrease in need for narcotics (Albert, Bateman and Klopp, 1954). Sadove, Levin, Rose, Schwartz and Witt (1954) found that pain was relieved by narcotics plus chlorpromazine when narcotics alone had failed and that the patients seemed more relaxed and spoke of pain as an objective phenomenon which they no longer minded although it was still present.

The first reported use of chlorpromazine in labour was in 1952 when it was given together with pethidine to 175 patients with good effect in 79 cases (Lacomme, Laborit, Le Lorier and Pommier, 1952). Labour was hastened in a third of the cases, retarded in another third, and not altered in the remainder. Röttger (1953) administered chlorpromazine in combination with promethazine and pethidine (the "lytic cocktail") by intramuscular injection to 150 patients in labour. Good relief of pain was achieved in 31 per cent of cases, fair alleviation in 41 per cent, while 28 per cent obtained no benefit. No ill effects were observed on the baby. Labour was slightly prolonged in *primiparae* but was of normal duration in *multiparae*.

THE TRIAL

The aim of this trial of chlorpromazine was twofold:

(1) To assess the analgesic effect of the drug in combination with pethidine and compare it with a control series of patients receiving pethidine, quinalbarbitone ("Seconal") and chloral.

(2) To observe the effect of chlorpromazine on uterine action.

Alternate patients in a series of 254 consecutive cases at Kingsbury Maternity Hospital were allocated on admission in labour into "Largactil" and "Control" groups. Those admitted for elective Caesarean section or delivered before arrival at hospital were excluded.

Patients admitted for antenatal treatment were not grouped until the onset of labour. Abnormal obstetric cases (breech presentations, twins, emergency admissions, trials of labour) were included in the series without selection.

Parity, Maternal Age and Birth Weights of Infants.

Apart from a slight preponderance of primigravid patients in the "Largactil" group (70 cases compared with 61 in the "Control" group), there was

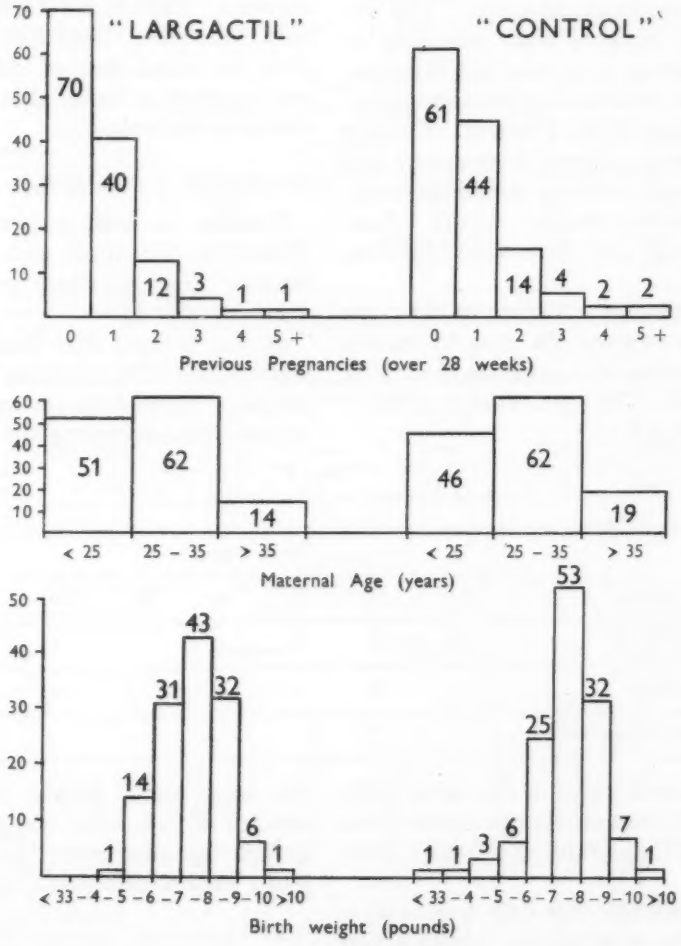

FIG. 1
Parity, maternal age and birth weights of infants in "Largactil" and "Control" groups.

little difference in parity, maternal age and the birth weight of the infants in the two groups (fig 1).

Method of Administration and dosage of Chlorpromazine.

There were 127 cases allocated to the "Chlorpromazine" group and of these 105 received chlorpromazine. The remaining 22 patients were admitted in advanced labour, at or near full dilatation of the cervix, and too late for administration of the drug to be of benefit. To have excluded these mothers, who mainly had easy and rapid labours, would have adversely affected results in the "Largactil" group and they were therefore included.

Chlorpromazine was given to 105 cases. Eighty-four received the drug by mouth, 18 by intramuscular injection and 3 by both routes. The total dosage given is shown in table I.

TABLE I
Route and total dose of chlorpromazine

Route	Dose (mg)						Total
	25	50	75	100	125	150	
Orally	10	42	17	10	1	4	84
Intramuscularly	–	18	–	–	–	–	18
Orally and Intramuscularly ...	–	–	–	3	–	–	3

In the earlier cases in the series, relatively small doses of chlorpromazine were given, i.e. 25 mg orally at 6-hourly intervals.

The initial dose was later increased to 75 mg orally or 50 mg by intramuscular injection and this was given when labour was well established. The observation made by Röttger (1953) that administration of the drug in early labour with weak and irregular uterine contractions will result in labour ceasing, was confirmed. Following the initial dose, chlorpromazine was given by mouth (in the absence of vomiting) in doses of 25 to 50 mg and this was repeated at not less than 6-hourly intervals. Pethidine, 100 mg intramuscularly, was given from half to one hour after the initial dose of chlorpromazine, and repeated as required at not less than 4-hourly intervals.

Assessment of Pain Relief.

Patients in both groups were interviewed on the third day of the puerperium. The questions and replies are shown in table II.

It was noticed that there was an extremely variable response to chlorpromazine. Some patients were unaffected whilst others receiving the same dose of the drug were deeply sedated. The amount of pain relief was similar in both groups but rather more "Largactil" cases had a hazy recollection of labour.

The "Largactil" group (127 cases).

Twenty-two of these patients were admitted too late for chlorpromazine and

most of these (18 cases) had gas and air. Labour was tolerable in 15 cases and in 6 it was intolerable; in 19 cases memory of events was clear and in 2 it was hazy.

Of the 105 cases who received chlorpromazine: 20 received chlorpromazine alone; 74 received chlorpromazine and pethidine; 11 received chlorpromazine with quinalbarbitone or chloral.

In addition to the four questions set out in table II, the 105 patients were asked on the third day after delivery what effect they noticed after receiving chlorpromazine. Their answers, together with the degree of pain relief and memory, are recorded in table III.

With the increase in dosage of chlorpromazine, the results are improved (table IV).

The drug appeared to have a cumula-

TABLE II

Questions and replies at third day interview

Question	"Largactil"				"Control"			
Was your labour tolerable or intolerable?	Tolerable	Intolerable	Don't know		Tolerable	Intolerable	Don't know	
	101	21	5		102	24	1	
Is your memory of the labour clear or hazy?	Clear	Hazy	Don't know		Clear	Hazy	Don't know	
	85	37	5		104	23	0	
Was your labour better or worse than you expected? (*Primiparae only*)	Worse	Better	Same	Don't know	Worse	Better	Same	Don't know
	7	21	3	39	7	19	5	30
Are your willing to have another baby? (*Primiparae only*)	Willing	Not willing	Don't know		Willing	Not willing	Don't know	
	40	8	22		36	11	14	
Was this better or worse than your last labour? (*Multiparae only*)	Worse	Better	Same		Worse	Better	Same	
	19	28	10		24	31	11	

TABLE III

Subjective effect of chlorpromazine as recorded at third day interview

Drugs	Analgesia			Memory			Subjective effect of chlorpromazine				
	Tolerable	Intolerable	Don't know	Clear	Hazy	Don't know	Drowsiness and good pain relief	Sleepy but no relief of pain	No recollection	No relief	Don't know
Chlorpromazine alone (20 cases)	80% 16	15% 3	5% 1	70% 14	25% 5	5% 1	15% 3	15% 3	10% 2	45% 9	15% 3
Chlorpromazine and pethidine (74 cases)	81% 60	15% 11	4% 3	61% 45	35% 26	4% 3	38% 28	17.5% 13	17.5% 13	23% 17	4% 3
Chlorpromazine and "Seconal" or chloral (11 cases)	91% 10	9% 1	0% 0	64% 7	36% 4	0% 0	46% 5	9% 1	27% 3	18% 2	0% 0

tive effect and patients having prolonged labours remained remarkably cheerful and unconcerned.

TABLE IV

Effect of increasing chlorpromazine dosage on analgesia and memory

Dose of chlorpromazine	Analgesia			Memory		
	Tolerable	Intolerable	Don't know	Clear	Hazy	Don't know
25–50 mg (70 cases)	80% 56	16% 11	4% 3	67% 47	29% 20	4% 3
75–150 mg (35 cases)	86% 30	11% 4	3% 1	54% 19	43% 15	3% 1

The effect of Chlorpromazine on "Gas and Air" Analgesia.

It was expected that the effect of gas and air might well be potentiated by the previous administration of chlorpromazine, and patients who had used the Minnitt's apparatus in labour were questioned as to its efficiency at the third-day interview.

The relief of pain obtained by breathing gas and air from the Minnitt's apparatus was not influenced by the previous administration of chlorpromazine. In the "Largactil" group 39 per cent experienced good relief with gas and air and 28 per cent found it ineffective. In the "Control" group 37 per cent obtained good relief and 24 per cent found it ineffective.

The effect of Chlorpromazine on Uterine Action.

The total length of labour was significantly prolonged by chlorpromazine. Labours lasting for more than 24 hours were twice as numerous in the "Largactil" group (fig. 2), and the average length of labour was increased from 12 hours 25 minutes in the "Control" group, to 18 hours 50 minutes in the "Largactil" group.

The second stage of labour was similarly prolonged. In 19 cases the second stage lasted for more than 2 hours, whilst only 5 cases occurred in the "Control" group (fig. 3). The average length of the second stage was 43 minutes in the "Control" group and 60 minutes in the "Largactil" group.

This prolongation of labour due to chlorpromazine occurred in *primigravidae only*. The length of labour in *multigravidae* in both "Largactil" and "Control" groups was the same.

Many of the patients who received more than 100 mg of chlorpromazine were indifferent to their surroundings and to their labour pains. During the second stage of labour this indifference resulted in poor expulsive efforts being made with a consequent increase in the number of forceps deliveries.

There were 16 forceps deliveries in the "Largactil" group and 4 in the "Control" group. In the "Largactil" group, 14 of the 16 forceps deliveries were performed wholly, or in part, because of uterine inertia.

The effect of Chlorpromazine on the Infant.

The condition of the newborn infant was unaffected by the administration of chlorpromazine to the mother in labour as judged by:

(1) The time interval between the birth of the infant and its first breath. This

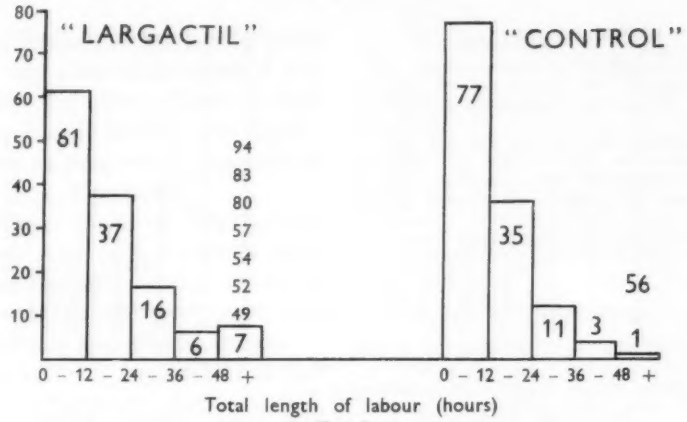

FIG. 2

Total length of labour in "Largactil" and "Control" groups.

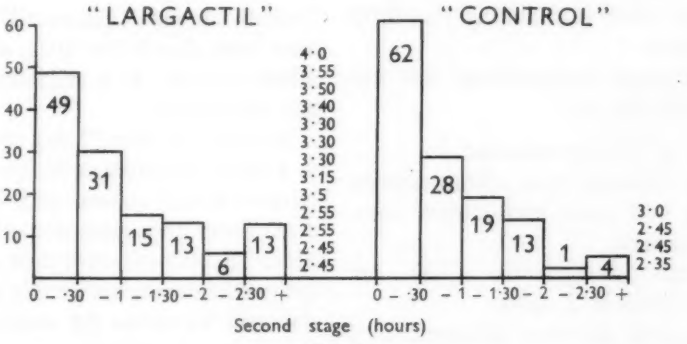

FIG. 3

Length of second stage of labour in "Largactil" and "Control" groups.

interval exceeded 1 minute in 4 infants in the "Largactil" group and 7 in the "Control" group.

(2) The infant's colour at birth. There were 5 infants with white asphyxia in each group; 18 infants in the "Largactil" group and 24 infants in the "Control" group were cyanosed at birth.

(3) The number of infants requiring active resuscitation (e.g. oxygen or nikethamide). There were 16 such infants in the "Largactil" group and 17 in the "Control" group.

(4) The stillbirth and neonatal death rate. In the "Largactil" group there was 1 stillbirth (undiagnosed disproportion) and 1 neonatal death from intrauterine asphyxia due to placental separation. In the "Control" group there was also 1 stillbirth (macerated twin, 1.24 kg) and 1 neonatal death (prematurity, 1.45 kg).

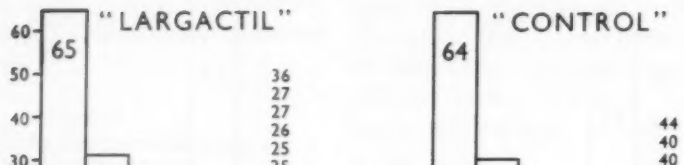

FIG. 4
Third stage haemorrhage in "Largactil" and "Control" groups.

The third stage of labour.

No unfavourable effects of chlorpromazine were observed during the third stage of labour.

The postpartum haemorrhage rate was not increased (fig. 4).

Side effects of Chlorpromazine.

Vomiting followed oral administration of the drug in 5 cases and 2 more complained of nausea.

Pronounced tachycardia (120 per minute) occurred in 2 cases.

Sweating and dizziness occurred in 1 case and skin pallor was noticeable in a number of cases.

Some transient local pain was produced at the site of the intramuscular injection and, in one case, this persisted for three days.

CONCLUSIONS

Chlorpromazine has no adverse effects on the foetus or on the third stage of labour.

It has no advantages over quinalbarbitone and chloral in producing sedation and appears to prolong the length of labour in primigravidae. The fourfold increase in the number of forceps deliveries in the "Largactil" group may have been due to the drug, and its routine administration as a sedative in labour is not advocated.

In doses of over 75 mg chlorpromazine is a more effective sedative than quinalbarbitone and chloral and, in addition, it potentiates the analgesic effect of pethidine. In this effective dose chlorpromazine produces uterine inertia in primigravidae and increases the number of forceps deliveries fourfold. Consequently its routine administration to patients in labour is not advocated.

SUMMARY

(1) Alternate cases in a series of 254 patients in labour were allocated into "Largactil" and "Control" groups. The "Largactil" group received chlorpromazine and pethidine, and the "Control" group received quinalbarbitone, chloral and pethidine.

(2) The sedation and analgesic action of chlorpromazine was assessed by ques-

tioning the patient about her labour pains on the third day after delivery, and was compared with the effect obtained from quinalbarbitone and chloral. No significant difference in pain relief was noticed in the two groups of patients.

(3) With larger doses of chlorpromazine, better sedation and analgesia were obtained, but uterine inertia occurred, labour was significantly prolonged and the forceps delivery rate was increased.

(4) "Gas and air" analgesia was not potentiated by chlorpromazine.

(5) Chlorpromazine had no adverse effects on the infants or on the third stage of labour and no severe side effects of the drug occurred.

ACKNOWLEDGMENTS

My thanks are due to Dr. Fairer of Charing Cross Hospital for his help at the commencement of this trial and for his advice regarding the dosage of chlorpromazine.

I also wish to thank the staff of Kingsbury Maternity Hospital for their willing co-operation, and Mr. Everard Williams, Miss Josephine Barnes and Mr. Robert Rees, under whose care these patients were confined.

Largactil (chlorpromazine hydrochloride) for this trial was generously supplied by May and Baker Ltd.

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THE ROLE OF THE ANAESTHETIST IN THE TREATMENT OF TIC DOULOUREUX*

BY

W. N. ROLLASON

A LITTLE over a century ago the discovery of anaesthesia gave to mankind the inestimable boon of unconsciousness and freedom from pain during surgery. The obliteration of this pain for long remained the sole function of the anaesthetist.

In recent years, however, the scope of his work has broadened. He is now expected to be a physician as well as a technician and to play a part in the diagnosis and treatment of intractable pain. Into this domain falls that most distressing disability called trigeminal neuralgia. This was not recognized as a special entity apart from other pains about the face and head until the middle of the 18th century when Nicolaus André called it "Tic Douloureux" (Harris, 1937). During the early 19th century, after tic douloureux had been definitely pinned on to the trigeminal nerve (formerly it was thought to be due to the facial) numerous operations were undertaken, and from these evolved the highly effective intradural segmental resections of today. It was, however, not until 1910 that Harris injected the gasserian ganglion with alcohol through the foramen ovale. He used the lateral approach, and this was followed in 1912 by the anterior approach of Hartel.

On the basis of histological studies Rowbotham (1954) suggested that the lesion in trigeminal neuralgia is essentially peripheral, consisting of a "perifilamentous adhesive neuritis."

During the past four years I have had 23 cases of supposed trigeminal neuralgia referred to me at my anaesthetic outpatient clinic (13 were females and 10 males, and their ages ranged from 37 to 79 years).

Of these 23 cases, 18 had true tic douloureux, two were functional and responded to psychotherapy, one was secondary to advanced Paget's disease of the skull, one was secondary to a meningeoma in the region of the foramen ovale, and one was associated with arthritis of the cervical spine which responded to a therapeutic block of the 2nd and 3rd cervical nerves with Proctocaine and alcohol. In this connection it is interesting to note that Wyburn-Mason (1953) has treated tic douloureux by alcohol block of the great auricular nerve which originates from the roots of C2 and C3.

I have attempted to inject the gasserian ganglion with absolute alcohol on 24 occasions, with success in 20 instances. The four failures involved two patients both of whom were referred to the neurosurgeon who has performed root sections on them with good results. Two of the initially successful injections have relapsed, one after two years and the second

* Paper read before Yorkshire Society of Anaesthetists on March 2, 1955.

after three years. Each has been re-injected with apparent success.

INVESTIGATIONS

It has long been established that diagnosis precedes treatment and investigation precedes diagnosis.

In each case referred to me the following investigations were done as a routine:

X-ray of the base of the skull to exclude any osteoporosis which may be produced by a meningeoma in the region of the foramen ovale and to exclude any anomalies such as a pterygo-spinous bar lying across the *foramen ovale*, or fusion of the foramen ovale with either the *f. spinosum* or the *f. lacerum* which would make injection difficult or dangerous.

X-ray of sinuses to exclude sinusitis.

X-ray of jaws to exclude the presence of any buried dental roots.

W. R. and Kahn tests to exclude a specific lesion.

Nature of pain. There is only one constant feature in the diagnosis of tic douloureux and that is the symptom of pain, and it is important to take an accurate history of this pain which must possess the following five features. It must be: (1) Unilateral. (2) Trigeminal in origin and distribution. (3) Severe. (4) Paroxysmal. (5) Precipitated.

Given all five of these features the diagnosis is made; the absence of even one of these preclude it (Penman, 1949).

Approximately 5 per cent of cases become in a sense bilateral usually years after the onset but at any given moment the pain neither begins on both sides nor passes from one side to the other.

The pain always originates in the trigeminal area and is usually confined to it. Only rarely is there a truly extra-trigeminal radiation.

The pain is often agonizing from the moment of onset and nearly always within a year or two it becomes the worst in the patient's experience.

"Paroxysmal" implies sudden beginning, sudden end, short duration and symptomless intervals. The duration is commonly anything from a split second to five minutes or more.

The commonest precipitants in approximate order of frequency are chewing, talking, washing or otherwise touching the affected side of the face, the mere pressure of food in the mouth, head movements, bodily exertion, jarring of the feet in walking, and cold winds.

Trigger zones almost certainly occur in no other disease. A light touch on small areas of skin or mucous membrane is particularly apt to provoke the characteristic pain.

The two lower divisions are involved equally commonly. The ophthalmic division is affected in not more than 5 or 10 per cent of cases and nearly always after the maxiliary; and onset only in the ophthalmic division is rare but not unknown.

Autonomic disturbances commonly found on the affected side during paroxysms are reddening and watering of the eye, running of the nostril, reddening of the cheek and salivation.

Normality of the trigeminal nerve on clinical examination is usual, but slight hyper- or hypo-algesia may be elicited. Facial analgesia and absence of the corneal reflex, however, are not found.

The "points de Valleix" are tender

areas over the exit foramina of the trigeminal branches and may be present.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis of tic douloureux is important. Dental pain and the pain of sinusitis are usually continuous and aching in character.

Atypical neuralgia is often simultaneously bilateral, often severe in the occiput neck, usually continuous for hours and often incessant; true precipitants do not occur. Campbell and Lloyd (1954) consider that it is related to the sympathetic nervous system in the neck and to the release of histamine. They are of the opinion that the immobilization of the neck in slight extension in a plaster collar breaks a vicious circle with consequent relief of pain in a substantial proportion of cases.

In post-herpetic trigeminal neuralgia there is a history of shingles, the affected area is scarred and is analgesic. The pain is incessant, there are no true precipitants, and the almost invariable site is the ophthalmic division. Like atypical neuralgia nothing short of surgical leucotomy would appear to give relief, although in these days of chemical leucotomy chlorpromazine with or without an analgesic would no doubt be worthy of trial.

Migrainous neuralgia and ciliary neuralgia are limited to the eye, its neighbourhood and the temple. The attacks usually begin gradually and last several hours. Some cases are relieved by trigeminal injection.

Glossopharyngeal neuralgia consists of brief paroxysms of agonizing red-hot stabs brought on usually by swallowing and coughing. It differs from tic douloureux in its much greater rarity and its sites; these are the back of the tongue, the soft palate, the tonsil, the pharynx and the ear drum. Choosing a time when nearly every act of swallowing is bringing on the pain, one can spray the affected side of the throat with a 5 per cent solution of cocaine; if this renders swallowing painless the neuralgia is glossopharyngeal.

Lastly one has to consider tumours. Primary trigeminal tumours are extremely rare. They are divided into those involving the sensory root causing facial numbness, and those of the ganglion causing continuous pain. Tumours secondarily involving the trigeminal nerve nearly always produce analgesia and often paralysis of the motor root.

TREATMENT

Having established the case to be one of true tic douloureux one must consider treatment which can be both palliative and radical.

Traussean (1861) said of Tic Douloureux, " I confess openly that I have never cured a single patient ". From croton oil to Christian Science, from hypnotism to hot air, almost every imaginable remedy has had its spurious triumphs. Since the precipitants include emotion and exertion it follows that sedation, rest and even the mere fact of treatment, no matter with what, will tend to give relief. Other apparent successes are really natural remissions.

Trichlorethylene in a pure state can produce relief by inducing a transient general analgesia. Impure trichlorethylene or trichlorethylene which passes through soda lime may contain dichloro-

acetylene, and this toxic product may cause trigeminal sensory loss with prolonged relief of pain.

A synthetic copper compound called Cuprelone (Campbell, 1948), has been tried in 100 mg doses intravenously twice weekly for a month, but has not stood the test of time. Nicotinic acid in 50 mg doses by mouth four times a day helps in some cases and should be pushed to the limit of tolerance before considering it a failure. This may be combined with phenobarbitone ½ grain (30 mg) twice daily.

Irradiation of the gasserian ganglion with both medium voltage and deep X-ray has been tried in three cases by Dr. G. E. Bannen (personal communication) with some success. He irradiates the ganglion with 100 r units weekly for four weeks.

More recently vitamin B12 (Cytamen) has been tried and favourably commented upon (Hughes and Surtees, 1954), but prior to resorting to injection I gave three of my cases 1,000 μg a day for three weeks with disappointing results.

When palliative measures fail, and in every case so far referred to me they have done so, radical treatment must be contemplated. This treatment must be described to the patient. He must be made to understand clearly two things: (1) That the proposed numbness of the whole of the affected side of the face will be permanent. It is important to stress this as some cases forget the pain they suffered and develop the syndrome of painful numbness. (2) That as a result of the treatment there may be temporary trouble with the eye on that side.

Questions should be encouraged and willingly answered. It may be necessary to point out the distinction between facial numbness and facial paralysis.

The pros and cons of root section and injection should be explained to him and he must choose or reject one treatment in favour of the other entirely by himself.

In the aged and infirm operation should be advised only if injection fails, whereas in the younger and relatively fit patient, and where the pain does not originate in the ophthalmic division, intradural segmental root section could spare the ophthalmic branch and so reduce the danger of neuroparallytic keratitis. It is important to discover in which division or divisions the pain originates rather than to where it spreads. Although the pain often spreads to the ophthalmic area it is unusual for it to originate there. On the other hand rhizotomy in the past has carried an overall mortality of 2 per cent, whereas the operative death rate for intracranial injection has been virtually nil, and for this reason should be recommended as the radical treatment to be tried first.

TECHNIQUE OF INJECTION

The injection of the gasserian ganglion has been referred to as the injection of two frightened people one at either end of a long needle. This quip implies, and rightly so, that it is not an injection to be undertaken lightly or without an adequate study of the anatomy of the region involved.

In my small series I have used the anterior approach of Hartel.

A mark is made with a throat swab dipped in Bonney's Blue one inch in front of the external auditory meatus in the middle of the zygoma. A line, called the

vertical line, is drawn parallel to the midline down the cheek from the external angle of the orbit with the aid of a metal rule. A point is marked on the line $1\frac{1}{2}$-2 cm above the angle of the mouth. This point is usually at a height about midway between those of the *ala nasi* and the angle of the mouth in the average case, and gives an angle between the needle and the anterior surface of the petrous bone (petrous needle angle) of zero or nearly so. From this point a line called the pupil line is drawn to the lower eyelid in the direction of the pupil when the eye is looking straight forward. From this point also a line called the zygoma line is drawn to the point marked on the zygoma.

The point on intersection of the pupil, vertical and zygoma lines is called the puncture point (figs. 1 and 2), and at this point a wheal of 2 per cent procaine is raised. This can usually be achieved painlessly by using a sharp No. 19 Vim needle with the bevel parallel to the skin and applying pressure on the skin whilst injecting.

Through this wheal an ordinary 22 S.W.G. Howard Jones spinal needle, to which a rubber depth recorder has been attached, is inserted. This needle is passed backwards, upwards and inwards in a line just above the zygoma line, and in a line midway between the vertical and pupil lines. At a depth of 5–7 cm the needle strikes the great wing of the sphenoid anterior to the *f. ovale* and the latter is then located by touch and inference. A skull is used for guidance.

It is important not to insert the needle below the zygoma line as it may then reach the carotid canal or the jugular foramen. If the needle is inserted too medially it

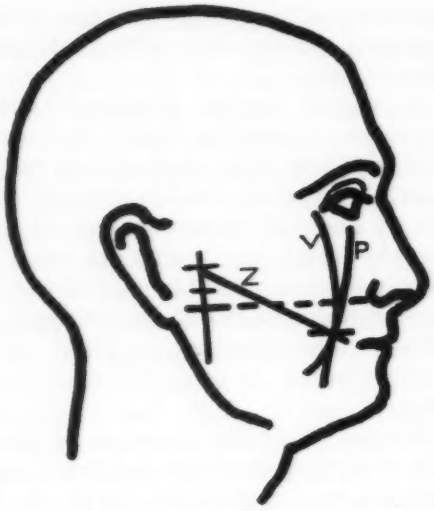

FIG. 1
Z = Zygoma line.
V = Vertical line.
P = Pupil line.

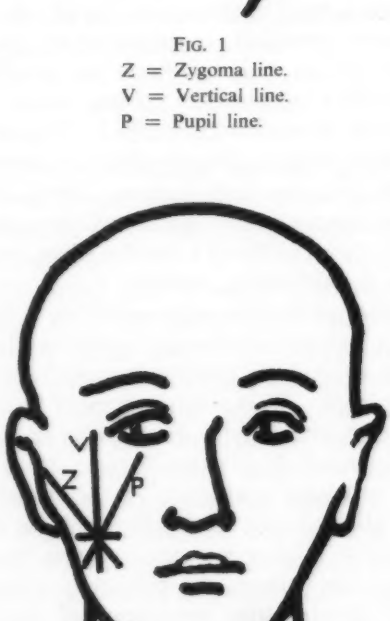

FIG. 2
Z = Zygoma line.
V = Vertical line.
P = Pupil line.

will strike the outer wall of the maxillary antrum, or deeper the external pterygoid plate, or deeper still the *levator palati* may be punctured causing pain referred to the throat or the eustachian tube may be touched giving rise to pain in the ear. It should be remembered that this pain in the ear may have two different origins. It may be due to a puncturing of the eustachian tube or it may be due to touching the auriculo-temporal branch of the mandibular division. This branch usually arises by two roots which encircle the middle meningeal artery. Injection of a few drops of procaine at this juncture will decide in which of those two sites the needle point lies.

The *f. ovale* having been found and entered the needle point must be advanced 1–1½ cm into the ganglion. The stilet of the needle is then removed to see if there is a flow of C.S.F. or blood. The internal jugulars are compressed at this stage in an endeavour to raise the C.S.F. pressure. If C.S.F. flows the needle is withdrawn very gradually until this flow ceases, and 2 minims (0.1 ml) of 2 per cent procaine are injected, using a 1 ml tuberculin type of syringe graduated in units of 0.01 ml. If no analgesia follows the needle point may be lying in the Cave of Meckel. The needle should then be withdrawn 1½ cm, the point dipped slightly to feel the bone below the foramen and then carefully slipped upwards to graze the lower edge of the foramen as it enters the ganglion and procaine re-injected.

If complete analgesia of all three divisions follows, 2 minims (0.1 ml) of absolute alcohol are injected. This usually causes pain and flushing of the face and no further alcohol is injected until this passes off, and in any case there should be a wait of at least 2 minutes between injections. A total of 1 ml of absolute alcohol is injected in divided doses of 2 minims (0.1 ml). If larger amounts of alcohol are injected at one time there is a danger of bursting the ganglion. Alcohol could then spread along the base of the skull with the possibility of permanent damage to the 6th, 7th and 8th cranial nerves resulting in strabismus, facial palsy, deafness and the vestibular syndrome respectively (Harris, 1937).

After the injection the patient is kept in hospital for the night and sent home the next day. He is requested to attend the anaesthetic out-patient clinic for follow-up.

Penman has employed radiological aid to inject the gasserian ganglion (Penman, 1949), with a higher incidence of good results, but radiology is not essential for success and is no alternative to skill and care. The injection is not always an easy one and should not be rushed. I allow myself up to a period of one hour.

EFFECTS OF INJECTION

Prior to the injection the patient is referred to an ophthalmic colleague for examination of the cornea, and in order to obtain a prescription for trigeminal spectacles. The eye on the affected side is kept covered until these spectacles are obtained. In spite of precautions keratitis developed in three of my cases and a tarsorraphy proved necessary in two of them.

Other after effects of gasserian ganglion injection are:

(1) *Temporary paralysis of the motor*

root. This lies underneath the ganglion but enclosed within the sheath. As the trophic centre, however, is within the pons regeneration takes place with the improvement in the power of biting after three months.

(2) *Paraesthesiae* of tingling and burning in the anaesthetic area with occasional shooting pains in the eye and temple. These are referred to as "Gasserian Ghosts" and may be psychogenic in origin or may be due to a sympathetic neuralgia. The patient should be reassured that they do not mean a relapse.

(3) *Fibrosis of the deeper tissues*. This is due to numerous injections over the course of years and may make it impossible to manipulate the needle and then rhizotomy becomes obligatory.

(4) *Diplopia*. This is an occasional immediate result of gasserian injection and occurred in one of my cases. It is due to a weakness of the 3rd, 4th, or 6th nerve. All three run in the lateral wall of the cavernous sinus to which the ophthalmic division of the gasserian ganglion is closely adherent, the alcohol injection causing the ganglion to swell with oedema. Diplopia lasts from 2 to 3 minutes to a maximum of 3 months.

(5) *Horner's syndrome* due to involvement of the sympathetic fibres passing over the ganglion from the carotid plexus occurred in one of my cases.

(6) *Herpes*. Vesicles developed around the lips, chin and side of the nose in two of my patients a day or two after injection. Unlike herpes zoster, however, these vesicles heal leaving no scars, paraesthesiae or neuralgia.

(7) *Atrophic ulceration in the insensitive area*. This occurred in one of my cases involving the side of the nose and the upper lip. It proved refractory to ordinary medical measures but responded to a series of 4 stellate ganglion blocks, the anterior paratracheal approach being employed and on each occasion 10 ml of 1/500 amethocaine and 1,000 μ of hyaluronidase were injected.

In conclusion, it should, I feel, be the rôle of the anaesthetist, particularly in centres where there is no neurosurgical unit, to diagnose accurately and treat effectively cases of true tic douloureux, and as a rule only in those cases where injection would be unwise or impossible should neurosurgery be advised.

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SELF-RETAINING INTRAVENOUS NEEDLE PLATE

BY

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MOST devices for retaining the needle in the vein for continuous drip anaesthesia on transfusion, such as the Gordh and others, serve well in their own way, mainly depending for their security on a strap of rubber secured around the limb. This works very well indeed, provided the chosen vein is on the leg or arm, and is in line with the longitudinal axis of the limb. When, however, the needle has to be inserted at an angle and then secured with a strap it tends, on movement, to puncture through the vein wall. The choice of sites other than the limbs may be called for by the nature of the operation, or the poverty of the veins in these members. As a forlorn hope the back of the hand so often remains the only solution, and it is here that the strap method is useless.

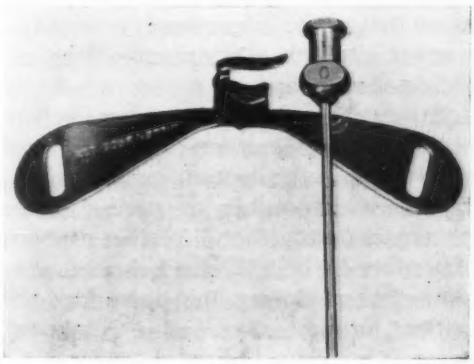

FIG. 1

To overcome these difficulties I have had made for me the plate illustrated (fig. 1). It consists of a metal plate, malleable, and therefore easily made to conform to any angle or contour of the selected site. It is two inches long and is fixed with a strong steel clip, capable of holding fast any size of needle bezel. At the tip of each wing of the plate there is a slit to which strapping can be attached, or, if more security is desired, the apparatus can be stitched to the skin with a pair of fine stitches.

When in place, it prevents the movement of the needle in the vein, in any direction, and remains secure in spite of the most violent movements of the patient.

The needle is inserted into the vein either attached to a syringe or otherwise. The plate is gently placed underneath and clipped into the bezel of the needle, and the plate secured to the skin.

ACKNOWLEDGMENT

I am indebted to Mr. Williams, of Willen Bros., New Cavendish Street, for many useful suggestions, and for making the model for me.

ON CHLOROFORM AND OTHER ANÆSTHETICS

THEIR ACTION AND ADMINISTRATION

BY

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Licentiate of the Royal College of Physicians

(*Continued from page* 266)

The rigidity and struggling previously mentioned (pages 264 and 266) as occurring occasionally in the third degree of narcotism, more particularly in robust persons, often form a very prominent feature in the effects of chloroform; and have sometimes caused the medical man to discontinue the exhibition of chloroform, under the belief that it did not agree with the constitution of the patient, and that its further exhibition would be unsafe. The proper course to pursue is to continue the inhalation gently, till the struggling and rigidity are subdued. The patient is often insensible before these symptoms are subdued, but it is necessary to have him quiet, in order to enable the surgeon to operate with convenience and safety. I have always succeeded in subduing the involuntary struggling and rigidity, but have occasionally occupied five or six minutes in doing so. It is desirable to proceed slowly and cautiously, because, when these symptoms occur, the patient has already absorbed nearly the usual quantity of chloroform, and he often holds his breath, and then takes a sudden and deep inspiration, when he might inhale an overdose of vapour, unless it were presented to him in a well diluted state.

When the rigidity and struggling are subdued, the breathing, in some cases, becomes stertorous, and relaxation of the muscles takes place, the limbs appearing quite flaccid; but by proceeding gently, these effects may generally be avoided, and the patient becomes quiet, whilst the breathing is natural, and the muscles are in a moderate state of tension. If the operator should be afraid to proceed with the exhibition of chloroform, on account of the violence of the muscular spasm and rigidity, it will be satisfactory to him to know that, if the inhalation is resumed in a few minutes, these symptoms will be less violent than at first.

Struggling and rigidity are less likely to occur, when chloroform is administered slowly, than under opposite circumstances; but it is impossible to prevent these phenomena altogether in certain patients. After they are once subdued, they but very rarely recur during the operation; the patient, in most cases, seems to take on, when he is subdued by the chloroform, the same relation to it that women, children, and persons in a state of debility have from the first. M. Chassaignac has called this condition one of tolerance of the chloroform. It is a condition in which the patient

bears both the chloroform and the operation very comfortably; but tolerance of a medicine is generally meant to imply that the patient can take it in larger quantity than before. But this is the reverse of what occurs when the patient is in a tranquil state from chloroform; he has already absorbed a considerable quantity, which has most likely penetrated deeply into the tissues, and he certainly does not require, and could not bear, so much as in the earlier stage of inhalation, where he is restless and breathing more quickly, and thus exhaling and getting rid of the chloroform at a greater rate.

It might be a question whether the absence of muscular excitement, in a number of cases, does not arise from the circumstance that anæsthesia, or absence of common sensibility, is obtained, and the operation performed, at a stage of narcotism anterior to that in which the muscular rigidity and spasm occur. This is true in a few cases, but I am satisfied by careful observation that, in the greater number of instances in which muscular excitement is absent, it would not occur at all, though the inhalation should be pushed to the most extreme degree. Many animals also are killed by chloroform without the least excitement of the muscular system occurring at any part of the process.

The pupils of the eyes are dilated in the deep state of insensibility which I have called the fourth degree of narcotism, but it is desirable to avoid carrying the effects of chloroform to this extent. They are occasionally dilated, however, under the slighter effects of chloroform, and even as the patient is recovering from its effects. In the third degree of narcotism, when the eyes are turned upwards, the pupils are usually, if not always, contracted; there seems to be a consentaneous action in the iris and the muscles which turn up the eye. The pupils seem also to be less sensitive to light, when the patient is insensible from chloroform, than at other times. This is all the information I am able to give about the pupils. Some writers have entered into a good deal of detail about the pupils, but their statements are very conflicting. The pupils are acted on by other causes, both external and internal, as well as the chloroform. The amount of light has great effect on them; and I have seen them remain dilated for some time after the chloroform was discontinued, and then suddenly contract, as the patient began to use his eyes. Even if definite laws could be ascertained with regard to the action of chloroform on the pupils, in different doses, and under different conditions, there would be some difficulty in applying them during the administration of the vapour, as the patient cannot be made to direct his eyes to or from the light. There is also some difficulty in making correct observations on the pupils. Very often, when I am exhibiting chloroform, one of the bystanders lifts the patient's eyelid and makes a remark on the state of the pupil, and, on my looking in the face of the speaker, I often have occasion to tell him that his own pupils are quite as much dilated, or contracted, as the case may be.

With regard to the position of the eyes, they are usually turned upwards in the third degree of narcotism, as I have already said, but in a considerable number of instances they retain their usual position all through the inhalation. In a few cases, they are turned downwards, the pupils being almost hid under the lower eyelids,

and causing a curious expression. I have noticed this most frequently in children of ten to fourteen years of age. I have scarcely ever seen temporary strabismus under the influence of chloroform.

The length of time which it is most desirable to occupy in the administration of chloroform, before the commencement of an operation, is about two minutes in infants, three minutes in children, and four or five minutes in adults. Circumstances occasionally occur, however, to lengthen these periods. The time during which the adult patient usually remains conscious whilst inhaling, is about two and a half minutes, but this period is sometimes prolonged from the nervousness of the patient, or his intolerance of the pungency of the vapour. Again, when unconsciousness is induced, there is, in many cases, an increased flow of saliva; and although this usually causes no impediment, the patient sometimes keeps making efforts of deglutition which very much retard the inhalation; and, at other times, he holds his breath, with his mouth full of saliva, as if he had some obscure idea of disposing of it in a suitable manner.* The delay which often arises from the struggling and rigidity has been already mentioned; but notwithstanding all these circumstances, it hardly ever takes more than seven or eight minutes to make a patient sufficiently insensible.

I have indeed met with a few cases in which a longer time has been occupied, but there has always been a physical reason for it. I have never had occasion to attribute the delay to any idiosyncracy, or great peculiarity in the patient, but only to the circumstance that the vapour did not enter the lungs in sufficient quantity within a given time. I have had under my care several patients who, it was supposed, were not susceptible of the effects of chloroform, or were, at least, very difficult to bring under its influence, as previous attempts had failed. It so happens, however, that I have had no difficulty whatever with any of these cases.

Two or three female patients who were about to undergo some trifling operation, preferred to leave off before they were unconscious, on account of unpleasant sensations in the head or chest, and to have the operation performed without the full effects of the chloroform; but there is no doubt the agent would have acted well enough if it had been continued.

The following case will show that chloroform may be inhaled with advantage in cases which at first seem very unfavourable. I received a note in 1849 from a medical man in the country, in which he says: —" I have now a young lady under my charge, from whom I am about to remove a tumour attached to the ear. She is anxious to take chloroform, and by the desire of herself and mother, I yesterday administered it by way of a trial, but only to what would be termed the second, and perhaps you would say, the first degree. She lost some sensation; but was quite conscious, and spoke. She felt giddy; there was tumultuous beating of the heart, and a much accelerated pulse, with a dilated pupil; a perfect coldness over the whole skin, with an equally cold perspiration;

* I have reason to conclude that the increased secretion of saliva is caused, not so much by the action of the chloroform on the mucous membrane of the mouth, and the extremities of the gland ducts, as by its action on the capillary circulation of the glands themselves; for on inhaling the vapour carefully by the nostrils, so that none enters the mouth, I still find that there is an increased secretion of saliva.

and, during recovery from this slight effect, severe tremors of the whole body, so much so as to shake the couch on which she was lying. From this state she did not recover for nearly an hour. She complained of great giddiness and oppression at her chest. She is a healthy looking, florid girl, but not strong, and has had, from time to time, severe spasm affecting her chest, so much so as to take away her breath. I have thus endeavoured to give you an outline of the constitution of my patient, how she had suffered, and what were the effects of the small dose of chloroform given by an inhaler. I never witnessed such extreme cold, tremor, or such tumultuous action of the heart; and am therefore anxious for the opinion of one who has administered chloroform under a greater variety of circumstances than myself, and to learn whether the symptoms I have described are sufficient to deter one from giving a sufficient dose to cause entire suspension of consciousness. My own impression is that they are sufficient to deter, but the patient and her friends being both anxious it should be inhaled if possible, I shall only be too glad to hear that you have witnessed like symptoms, and that you do not consider them sufficient indications of danger to deter me from its careful administration in the case."

I advised that the chloroform should be administered again, and continued steadily till the patient should become insensible; expressing my belief that the unpleasant symptoms would subside as unconsciousness was induced. I received a reply to the effect that the operation had been performed very successfully under the influence of chloroform, although the vapour had an exciting effect for some time.

Repetition of Chloroform during an Operation. The first application of chloroform often suffices for an operation, if it be of short duration, without repeating the inhalation. In a few cases the patient remains insensible to the knife for three minutes after the inhalation is left off, but this is an exception; and one cannot, at all events, make sure of this prolonged effect of chloroform, without producing a deeper state of narcotism than is desirable. More usually, if the operation lasts more than a minute or two, it is necessary to repeat the inhalation; it is, indeed, generally desirable to let the patient have a few inspirations of air charged with chloroform vapour every half minute or so, whilst the operation continues in order to keep up the insensibility. When the surgeon is cutting in the neighbourhood of important parts, it is desirable to prevent any sign of sensibility, and to keep repeating the chloroform so as to keep up the coma, without, however, causing embarrassment of the breathing or wide dilatation of the pupil. In the greater number of operations, however, it is better to wait till there is some sign of sensibility, such as a slight cry or tendency to flinch, before the inhalation is resumed; and then a few inspirations of well diluted vapour make the patient quiet again.

RECOVERY FROM THE EFFECTS OF CHLOROFORM

As soon as a patient has ceased to inhale, the chloroform begins to exhale in the form of vapour from the blood as it passes through the lungs. It cannot be detected by the sense of smell, after the lungs have

be emptied, by two or three expirations, of the vapour they contained at the moment when the inhalation was discontinued; but I have detected it by chemical means, after consciousness had returned. The chloroform exhales in greatest quantity at first, and the patient usually recovers his sensibility and consciousness in the time which it ought to take for the chief part of the chloroform to be exhaled, according to mechanical principles; as will be explained in treating of the *modus operandi* of this agent. The last traces of the chloroform of course exhale more slowly, and a very minute and insignificant quantity may remain for a considerable period in the system, not only of the patient, but of anyone who was standing by whilst he inhaled.

It is probable that a small portion of chloroform passes out by other channels than that of the expired air: the latter, however, offers such a ready and expeditious outlet, that the quantity excreted in any other way is, most likely, very minute. I have on four occasions examined urine passed after the inhalation of chloroform, by boiling it in a flask, and passing the vapour, first through a red-hot tube, and afterwards through a tube moistened inside with solution of nitrate of silver, and I only on one occasion obtained a very slight precipitate of chloride of silver.

The patient usually becomes conscious within five minutes after the inhalation has been discontinued. After a short inhalation, for a very brief operation, consciousness sometimes returns immediately, and after a prolonged inhalation the recovery of consciousness is sometimes retarded till ten minutes have elapsed. Old people are often longer than others in awaking from the effects of chloroform, owing, no doubt, to their slower breathing and circulation. Children, on the other hand, usually recover very quickly from its direct effects; but they often lapse into a natural sleep which lasts a considerable time—even for hours if they are not disturbed, and if the operation has left no painful wound or other cause of uneasiness.

It is desirable not to talk to the patient as he is recovering from the effects of chloroform, but to leave him to collect his ideas, and not speak to him till he is quite conscious, or makes some remark or inquiry himself. If not prevented by the medical attendant, the friends of the patient often address him the moment he opens his eyes; and the words they generally use are of a very equivocal meaning to one who cannot understand their application. They usually say "It's all over", which very often has the effect of raising an indefinite feeling of alarm in the patient; for, until he has had time to recover his memory, the operation he was to undergo is generally the farthest thing from his mind. When left to himself the patient usually recovers from the insensibility in a very tranquil manner. If he has not been moved whilst insensible, and awakes in the position in which he fell asleep, he supposes, very commonly, that he has not been asleep at all; and in a great number of instances will contend this point very stoutly, even after a protracted operation, and assert that the chloroform has not taken effect. It is as well to let him remain in this conceit for a while, or even till he finds out the mistake himself; for, if reminded of the pain they have been spared, just on waking after an operation,

persons are liable to be excited by emotions of pleasure and gratitude; but a few minutes later, when the effects of the chloroform have more completely subsided, they are better able to control their emotions. A few persons wake with a full recollection of the preceding circumstances, and inquire if the operation is done; whilst others, on first awaking, are still entirely occupied with the subject of their dreams.

The greater number of patients who inhale chloroform have to remain in bed on account of the operation which has been performed, but after minor operations, the patient is sometimes able to walk away within five minutes; although more frequently there is a little languor or feeling of fatigue for half an hour or so; and it is desirable in all cases for the patient to sit or lie quietly for this space of time, if not longer, before he makes any mental or bodily exertion, even if he feels quite well.

OCCASIONAL SEQUELAE OF THE INHALATION OF CHLOROFORM

Sickness. The chief drawback to the benefits conferred by chloroform is the sickness which in many cases follows its use. It is most frequent when the inhalation takes place soon after a meal, and some of the precautions which are requisite in order to avoid this symptom, or render it as rare as possible, have already been described (p. 155); but it occurs in certain cases, notwithstanding the best measures which may be used for its prevention. Moving the patient as the effects of the chloroform are subsiding is very apt to excite vomiting when it might not otherwise occur; it is therefore desirable, when convenient, to allow the patient to lie for half an hour or so, without moving his head from the the pillow. By this means, even when a feeling of nausea is present, it often subsides without the occurrence of vomiting. It is advisable also not to give the patient anything to eat or drink till about an hour after the inhalation, and, as a general rule, not even then, unless there is some inclination for it; for if anything is taken into the stomach before the effects of the chloroform have entirely subsided, it is apt to excite vomiting. Even medicine, such as an opiate, is better delayed for an hour or upwards unless there is an urgent necessity for giving it sooner. Severe faintness from loss of blood during an operation of course forms an exception to this rule; in such a case brandy and water should be given, and repeated if it should be vomited.

These rules respecting food are, moreover, meant to apply only to the use of chloroform in surgical operations, and not to its employment during labour. Under the latter circumstances, one allows the patient all the nourishment that is desirable, intermitting the inhalation now and then for the purpose. And chloroform, given in the moderate way in which it is employed in labour, hardly ever causes sickness, but often alleviates it when present from physiological causes.

The sickness induced by chloroform usually subsides of itself in the course of an hour, or even less; I, therefore, think it advisable not to do anything for it during this space of time. When it has continued beyond this period, I have found a little cold brandy and water to remove it in most cases; and when the tendency to vomit still remained after a

few hours, I have seen it removed by a dose of opium. Effervescing draughts have not appeared to be of service in the sickness from chloroform, and sal volatile and draughts of warm water seem injurious. It is desirable for the patient to make no effort, but only to vomit if obliged to do so.

Several cases have come within my knowledge, in which the sickness has continued for two or three days after every thing that was taken into the stomach. These cases have not been under my care, but under that of the surgeon. I have been informed, however, that all the usual remedies for sickness were applied for the time mentioned above without success. The cases in which the sickness lasts so long form but a very small portion of the whole number in which chloroform is administered, and they chiefly occur in persons who are subject to attacks of vomiting from slight causes, or, as they say, to bilious attacks.

The most usual time for the vomiting to commence is when the inhalation has been discontinued, and the effects of the chloroform are passing off. In many cases, it occurs before the patient has become quite conscious, and he does not know that it has occurred unless he is told. In a few cases, especially where there is a good deal of food in the stomach, the vomiting comes on before the operation is finished, or even before it is commenced. When vomiting comes on during an operation, it is apt to interfere with the inhalation, and it is sometimes difficult to prevent the patient from waking; but this can be accomplished by wiping the patient's mouth, and reapplying the chloroform, the moment the act of vomiting ceases. In many cases, however, the sickness does not come on till the patient is quite awake, and perhaps, even then, not until he moves. I believe that the sickness which is due to chloroform always commences within an hour or two, or at the farthest, just after the first food which is taken. I have known vomiting attributed to the chloroform which did not occur till the following day, but I ascertained that a dose of opium had been taken at night, and it was to this that the sickness was probably owing. In those cases where the chloroform does cause sickness in the first instance, it is not always the cause of all the vomiting which the patient may suffer. If the patient becomes infected or is inoculated with the poison of erysipelas or hospital gangrene at the time of the operation, he will probably be attacked with vomiting a day or two afterwards; and if sickness has already been caused by the chloroform, that which is due to disease may appear to be a continuation of it.

(*To be continued*)

CORRESPONDENCE

MECHANICAL VENTILATION WITH PULMOFLATORS

Sir,—In the May issue of your Journal, Dr. Dinsdale in his article entitled "Mechanical Ventilation in Thoracic Surgery with a New Pulmoflator" describes his method of using the apparatus in a series of thirty cases. Although I wish to express my thanks to Dr. Dinsdale for his interest in the apparatus, I cannot agree with his technique of using a Waters' soda lime canister in the circuit.

My original articles in the *British Journal of Anaesthesia* and the *British Medical Journal*, point out that the Pneumoflator was designed as a small attachment to Boyle's machine, so that rhythmic inflation of the lungs could be performed in the presence of trichlorethylene vapour. With this requirement in mind, the circuit of the apparatus was designed to reduce the mechanical deadspace to a minimum. A soda lime canister should never be used.

Readers will know that in the normal "to-and-fro" method of absorption by manual compression of a bag, the fresh gases are delivered to that part of the canister nearest to the patient. When soda lime is used in conjunction with this Pneumoflator, its design is such that the fresh gases would arrive at the machine side of the canister—away from the patient.

The volume of an 8 cm × 13 cm Waters' canister is approximately 650 ml, and the total inter- and intra-granular air space is 400–425 ml. If the patient's tidal volume is near or below this critical volume of the canister fresh gases can only reach the patient by a process of diffusion. Some rebreathing will occur and oxygen tension in the alveoli may fall. If a canister is not used, the apparatus delivers the fresh gases almost to the endotracheal tube, and the expired gases are swept away to the expiratory valve within the machine.

A further point of importance is that the machine requires a flow of 15 litres per minute to operate efficiently. This flow is equivalent to 250 ml per second. Therefore the normal tidal requirement of 300–500 ml will be delivered in 1½–2 seconds. Some allowance must be made for expansion of the corrugated tube, but inspiratory periods longer than 3 seconds would indicate a leak in the circuit, or the approach to excessive inflation.

It is widely accepted that positive pressure respiration, performed either mechanically or manually, may cause a fall in blood pressure in a small percentage of cases. My own experience with this Pneumoflator in over seven thousand patients, is that such cases are few. When it occurs the pulse rate does not increase to the extent which would be observed if haemorrhage were the cause, and a rapid return to normal blood pressure is usual once spontaneous respiration can be allowed.

At such times it is, however, advisable to check the adjustments of the machine by reverting to manual compression of the reservoir bag. The pressure on the manometer dial is noted and the machine readjusted to duplicate as near as possible the type of respiration indicated by manual control.

Naturally the use of a machine calls for the utmost care at all times, and a basic understanding of its design and method of use is essential.

I would be grateful if you can find space in your Journal for these observations.

T. M. WILLIAMS,
Morriston Hospital, Swansea

LARYNGEAL SPRAYS

Sir,—Many anaesthetists must have felt the need for an efficient cocaine spray, which is free from the danger of decanting liquid cocaine into the trachea.

Like Dr. Mortimer I came to the conclusion that an angle of 90° would be more suitable for the anaesthetist's use, and have for some years now used the Rogers' Straight Pharyngeal pattern spray which has this angle. This possesses in addition a nozzle long enough to be passed through the cords, thus permitting the trachea to be sprayed with certainty.

L. RENDELL-BAKER
Cardiff

PASSAGE OF SUCTION TUBE INTO STOMACH

Sir,—The occasion sometimes arises when it is necessary to pass a suction tube into the stomach while the patient is under general anaesthesia. I always found this a manoeuvre of some difficulty until I thought of first passing an endotracheal tube into the oesophagus to act as a guide. A Levin's tube—a Ryle's tube is too pliable—may then be passed into the stomach quite easily and the endo-oesophageal tube withdrawn leaving the Levin's tube *in situ*.

I am sure many other anaesthetists have employed this technique, but as I do not remember seeing or hearing it described I think it may be useful to bring it to the notice of your readers

REX BINNING

A MODIFIED MACINTOSH LARYNGOSCOPE BLADE

Sir,—In spite of many recent suggestions about different laryngoscope blade alterations, I will venture to suggest one more, which has the advantage of not entailing a special purchase.

The illustration shows how a portion of a Macintosh blade has been removed. This gives a greater degree of freedom when used in those patients who have all their lower teeth plus a narrow mandibular angle. The tongue does not encroach over the right margin of the blade (where the metal has been removed) any more than normal.

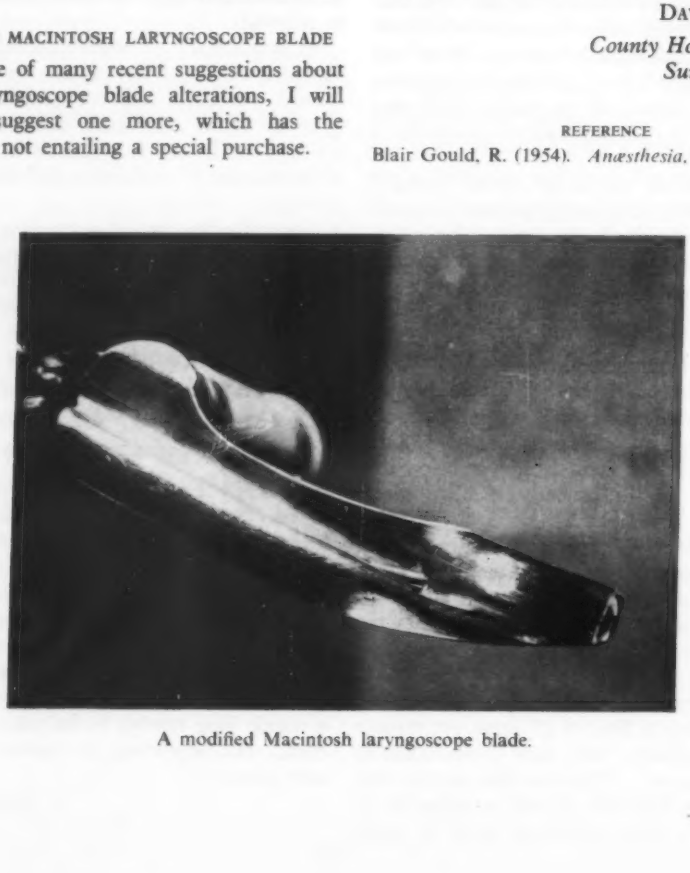
In 18 months' use I have found this an improvement in such cases and there has been no disadvantage in others. At times it would seem that even more metal could be removed.

Such a modification to R. Blair Gould's modification of the Macintosh blade would surely be an ideal curved blade—giving maximum freedom in people who have all their own teeth.

DAVID L. SCOTT,
County Hospital,
Sundsvall, Sweden

REFERENCE

Blair Gould, R. (1954). *Anæsthesia*, **9**, 125.



A modified Macintosh laryngoscope blade.

SOCIETY MEETINGS

THE YORKSHIRE SOCIETY OF ANAESTHETISTS

MEMBERS of this Society, accompanied by other anaesthetists from the North of England paid a three-day visit to Paris from April 25 to April 28. Visits to hospitals included a morning at the Broussais Hospital where two cases of cardiac surgery were anaesthetized by Mme du Bouchet and Mlle Parrelecq, and a session at the Vauquirard Hospital where Dr. Huegenard demonstrated a case of artificial hibernation. A visit was paid to the laboratory at the Val du Grace Hospital where Dr. Laborit gave a demonstration of experimental surgery under hibernation anaesthesia. The Society was privileged to attend a meeting of the Societe Francaise d'Anaesthesie, who also entertained the visitors to a cocktail party. Social activities included a visit to the Faculty of Medicine, a visit to Versailles, and a sail down the Seine.

The Annual Dinner of the Society was held in Leeds on May 11, the guest of honour on this occasion being Professor J. C. Goligher, Professor of Surgery in the University of Leeds. About fifty members and their guests, who included several members of the Surgical Staff, were present. Other guests included representatives of the Anaesthetic Staffs of Manchester and Sheffield. This function has been held in May this year in order to minimize travelling difficulties when the Dinner is held in the Winter.

THE SOCIETY OF ANAESTHETISTS OF WALES

THE 6th Annual General Meeting of the Society of Anaesthetists of South Wales was held at Porthcawl on May 31, 1955. The President, Dr. D. S. Jones, reported a successful year in which three meetings had been held with a large attendance of members.

The 1954 Autumn Meeting had been held at Porthcawl, when a film on Dextran was presented by Dr. Fee of Bengers Ltd., and a lively evening of discussion followed.

The 1954 Summer Clinical Meeting was held at the Plastic Surgery Centre for Wales at St. Lawrence Hospital, Chepstow. The morning session was spent in the theatres where anaesthetic cases were demonstrated by Dr. Middleton and Dr. Greatrex. The afternoon was spent in discussion of the points from the morning demonstration.

The Annual Dinner Meeting in the autumn was held at the Park Hotel, Cardiff, and was attended by 72 members and guests. Professor W. W. Mushin spoke of his experiences as "An Anaesthetist in Brazil", and illustrated his talk by many beautiful coloured slides made from his own photographs.

The Society has a large membership of anaesthetists throughout Wales, and it was agreed that the Society will henceforth be known as "The Society of Anaesthetists of Wales".

Officers for the forthcoming year were elected.

President: Dr. J. P. J. Jenkins.
Immediate Past President: Dr. D. S. Jones.
Honorary Treasurer: Dr. D. K. W. Picken.
Honorary Secretary: Dr. H. G. Middleton.

Members of the Council

Dr. L. Wilson
Dr. T. M. Williams
Dr. J. Lewis
Dr. Barbara Roberts

Papers presented at the meeting were: "Intra-arterial Thiopentone", by Dr. E. Harvey Franks; "Trilene Analgesia in Midwifery", by Professor W. W. Mushin; "Things Aren't Always What They Seem", by Dr. W. W. Mapleson; "Anaesthesia in the Treatment of Burns", by Dr. H. G. Middleton.

The 1955 Summer Clinical Meeting was held at Morriston Hospital at 10.30 on Saturday, June 18, and the Annual Dinner will be held on October 6, 1955, when the guest speaker will be Dr. Ronald Woolmer.

The Society of Anaesthetists of Wales issues a cordial invitation to anaesthetists from all parts who may be visiting Wales to join in the activities of the Society and to call upon its members.

LIVERPOOL SOCIETY OF ANAESTHETISTS

AT the Annual General Meeting of the Liverpool Society of Anaesthetists held at the Liverpool Medical Institution on May 20, 1955, the following Officers and Members of Committee were elected for the ensuing year:

President: Dr. R. J. Minnitt.
Vice-President: Dr. G. R. Hopper.
Honorary Treasurer: Dr. Hilda Garry.
Honorary Secretary: Dr. G. McLoughlin.

Committee
Dr. Noel Fenton
Dr. J. R. Esplen
Dr. G. Jackson Rees

The Society will be celebrating the 25th anniversary of its institution on Saturday, July 16, 1955, with a special anniversary dinner.

FACULTY NEWS

FELLOWSHIP OF THE FACULTY OF ANAESTHETISTS

THE following are the names of the 23 successful candidates out of the 61 candidates who presented themselves for the final examination of the Faculty of Anaesthetists in April.

Attygalle, L. M. V.
Black, G. W.
Brooks, W.
Brun, F.
Campbell, I. D.
Day, B. L.
Dempsey, Brenda M.
Fitzgerald, Margaret M.
Fraser, Rosemary A.
Hall, P.
Harrison, G. G.
Horsey, P. J.
Jenkins, A. V.
Kempthorne, P. D.
Lamb, W. R.
MacKinnon, A. G.
Mehta, M. D.
Penn, H. P.
Reid, A. M.
Roffey, P. J.
Scott, D. B.
Stuart, P.
Warltier, Betty R.

The following have been elected to the Fellowship of the Faculty:

Ansari, H. M. A.
Bennie, J.
Bigley, D.
Bridges, Margaret L. M.
Brown, A. K.
Brown, Margaret W.
Carstairs, J.
Chandler, C. C. D.
Clarke, A. D.
Connolly, Margaret R.
Coulter, R. L.
Davies, D. H.
De Freitas, A. J. S.
Dennis, Daphne
Drury Byrne, P. J.
Earnshaw, Averil
Fisher, Nancy G. S.
Fowler, E.
Frayworth, E. A.
Fry, E. N. S.
Gilchrist, D. T.
Graham, H. P.
Hamilton, Margaret D. W.
Hamilton, Norah H.
Harker, M. J.
Harrison, Roasalinde J.
Holloway, Cynthia M.
Hosford, M. D. C.
Houseman, G.
Hudd, H. R.
Hunter, Mary L.
Jackson, G. C. A.
Johnston, N. G.
Jones, Elizabeth B.
Kelly, H.
Kilpatrick, L. G.
Lee, R. E.
Lett, Z.
Lloyd, Mary E.
Mackenzie, A. I.
McArthur, Pauline
Mackay, Maria R.
McKinlay, A. McK.
Macqueen, M. C.
Matheson, D.
Mills, Margaret J.
Monro, J. W.
Nikitik, C.
Nunn, J. F.
O'Driscoll, Maureen
Ozorio, H. P. L.
Pallister, W. K.
Pallot, Doreen B.
Podesta, C. H.
Roche, G. K. T.
Russell, Eleanor H.
Smiedt, N. C.
Sorrell, Frances
St. Clair, J. D.
Sleigh, Beatrice E.
Smeeton, W. M.
Sykes, M. K.
Tate, N.
Venn, P. H.
Varma, H. P.
Winter, Edith de
Wislicki, Luise
Woodley, J.
Wright, G. V. S.

BOOK REVIEW

Local Analgesia: *Brachial Plexus* (3rd edition). By R. R. Macintosh, M.A., D.M., F.R.C.S., F.F.A.R.C.S., D.A., and W. W. Mushin, M.A., M.B., B.S.(Lond.), M.R.C.S., F.F.A.R.C.S., D.A. Published by E. & S. Livingstone Ltd., Edinburgh & London. Price 10*s.* 6*d.*

The fact of a third edition of this excellent and simple little monograph is a tribute to its continued popularity and usefulness. Although pruned to the bare essentials of technique and indications, there is a bibliography at the end of each section for reference where further detail is required. The technique is described with clarity and is therefore simple, and the description is admirably dogmatic.

The type of this third edition is rather bolder than that of the first, which is an improvement, and the description of sterilization of syringes has been brought up to date.

The section on local anaesthetic drugs has been rewritten since the first edition to include the use of lignocaine and hyaluronidase. The figure illustrating the relation of the cervical and upper thoracic chain has been redrawn and is now much clearer.

This is a little classic which should be on the shelves of all grades of anaesthetists.

T. Cecil Gray

Printed in Great Britain by JOHN SHERRATT & SON, Park Road, Altrincham